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Creating New Design Options for the Flint Road Recreational Complex

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Creating New Design Options for the Flint Road Recreational Complex

A Major Qualifying Project
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January 2011

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Authorship

The authors Nicholas Catano and Quontay Turner have both contributed to writing and editing of the paper. Nicholas contributed with the following sections: Abstract, Capstone Design Statement, Executive Summary, Table of Contents, Table of Figures, Table of Tables, Original Site Plans, Parcel Boundaries, Physical Constraints, Sports Fields Design Criteria, Lighting, Parking, Road Components, Loop design, Cul-de-Sac design , Permits and Regulations, Background Information, Site Visits, Generation of Land Map, Cut-and-fill, Use of AutoCAD, Design Proposal 1, Design Proposal 2, Evaluation of Options, and Recommendations. Quontay contributed with the following sections: Introduction, the History of the Flint Road Recreational Complex, Power Lines, Wetlands, Stormwater Management, Estimation of Costs, Conclusion, Appendix B, Appendix C, and the AutoCAD drawings of the design proposals.

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Abstract

This project involved the design of a site plan for the Flint Road Recreational Complex in Charlton, MA. The team recommended one of the two site plans to the Town of Charlton based on a process of revising a previous layout to accommodate the construction of a Department of Public Works facility; identifying site development requirements and constraints; and evaluating options. The design options were evaluated based upon environmental concerns, construction features, cost estimates, and input from community members.

Acknowledgements

This project would not have been possible without the help from a number of different people. We would first like to thank our Advisors, Professor Suzanne LePage and Professor Leonard Albano for connecting us with such an amazing project. Their feedback and guidance through the whole process was priceless.

To Karen Gauvin, the Town of Charlton's Recreation Committee member and Conservation Commission Agent, we thank you for giving us the opportunity to work on this project for the Town. The experience working with a client has been very valuable.

To Jeff Fasser from VHB, Jessica Farrell with the National Grid, and Leslie Fanger from BSC TerraSphere, we thank you for the time you have taken out of your schedules to answer our questions and provide us with information that was essential to the completion of our project.

Capstone Design Statement

The Major Qualifying Project is the result of knowledge gained from previous coursework and research in the field of civil and environmental engineering. In cooperation with ABET requirements, this project integrates eight realistic constraints. The eight constraints include economic, environmental, sustainability, constructability or manufacturability, ethical, health and safety, social, and political. Each of the real world constraints integrated into this project are summarized below.

Economic

The economic analysis of the project was satisfied by a cost estimation of two design proposals based on modified unit cost data from a previous site design, prepared by a professional engineering firm. This analysis and estimation has increased the project team's ability to incorporate cost-effectiveness into design.

Environmental

The project team was attentive to environmental concerns and constraints, by exploring regulations for storm water, wetlands, and power lines. The team worked to minimize negative environmental impacts as much as possible, which included a twenty-foot buffer zone around all wetlands.

Sustainability

The project team incorporated sustainability by involving long term use, and impacts to the area. This project taught the team to think of the immediate influence of the proposed design but also the impacts over time and to plan for possible changes.

Constructability

Constructability was a large portion of the project. The project team created the designs to manage and control cut-and-fill construction costs along with being mindful of the construction schedule the Town had laid out for the project. To appease town financial constraints the project team evaluated construction of the complex in phases.

Ethical

The NSPE Code of Ethics for Engineers was referred to and followed by the project team from the beginning to the end of the project. The project team created the designs with the best practices in mind, as well as the major impact on the surrounding area.

Health and Safety

Health and safety requirements were identified throughout the planning process. The project team kept safety a high priority when determining the road layout and design. The design also incorporated a 50 ft. no touch zone around the power lines. The project team also researched safety in the lighting of the fields. This aspect taught the team how to deal with the challenge of synthesizing the client's space needs with the spatial allowances necessary for health and safety.

Social

The social aspect of this project was very important, with the intended use of the facility purely social. The project team considered how to improve the social interactions within the recreational complex, such as incorporating a parking lot with the correct length to double as extra basketball courts. The project team also created a poster and presentation with the intention of informing the population of Charlton about the proposed project.

Political

Political impact is becoming more and more involved in the design process. The loss of two and a half acres to accommodate the Department of Public Works' highway facility was just one of the few political topics that affected this project. The project team also held meetings with town stakeholders including the Town Recreational Committee. To fulfill political requirements the project team prepared a presentation for the population of Charlton.

Executive Summary

On Flint Road in Charlton Massachusetts lies a heavily wooded and hilly parcel of land, which will soon become Charlton's first and only lighted sports recreational complex. When the Town first began planning for the complex in 2007, the original design consisted of a senior league baseball field, a little league field, a basketball court, multi-use field, a walking track, a central gathering area, and parking (Fanger, 2007). Planning for the Flint Road Recreational complex came to a halt when the Department of Public Works took over two and half acres to build their multi-million dollar highway facility. The Flint Road Recreational Complex has since been restarted with the help of a project team at Worcester Polytechnic Institute (WPI) to complete the educational requirements of their Major Qualifying Project (MQP).

The goal of this MQP was to create two new site plans that accommodated the construction of the Department of Public Works (DPW) facility and retained the Town of Charlton's wants and needs. The project team also worked to create a rubric to evaluate the two site plans and make a recommendation to the Town on which design proposal to proceed with.

The first design proposal, by request of the Town, dealt with the loss of land by removing the softball field. This design proposal still incorporated a senior league baseball field, a little league baseball field, a basketball court, a multi-use field, a quarter mile track, concession stand, and parking. The second design proposal was created through reorganizing the placement of each field to make room for the softball field. This design proposal incorporates everything that Design Proposal 1 includes along with the softball field. Using the evaluation rubric created by the project team, Design Proposal 2 was recommended to the Town of Charlton.

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Introduction

On Flint Road in Charlton Massachusetts lies a heavily wooded and hilly parcel of land, which will soon become Charlton's first and only lighted sports recreational complex. When the Town first began planning for the complex in 2007, the original design consisted of a senior league baseball field, a little league field, a basketball court, two multi-use fields, a walking track, a central gathering area, and parking area (Fanger, 2007). Planning for the Flint Road Recreational complex came to a halt when the Department of Public Works took over two and half acres from the northeastern corner of the land parcel to build their multi-million dollar highway facility. The Flint Road Recreational Complex has since been restarted with the help of a project team at Worcester Polytechnic Institute (WPI) to complete the educational requirements of their Major Qualifying Project (MQP).

The goal of this MQP was to create two new site plans that accommodated the construction of the Department of Public Works (DPW) facility while balancing the amount of cut and fill, addressing the constraints of the property and meeting the Town of Charlton's expectations for the Flint Road Recreational Complex. To assist the Town in the completion of this project, a comprehensive list of permits and next steps needed for the construction of the complex was also compiled.

The project team researched preliminary information for the Recreational Complex including the recent history of the Flint Road Recreational Complex, Charlton's zoning bylaws, and permits and regulations involved in construction projects. For the design aspect of the site, the project team researched baseball and turf field design along with requirements to meet the requirements for road components, proper lighting, parking, and Americans with Disabilities Act (ADA). The project team also met regularly with a member from the Recreational Committee to ensure that the Town's expectations for the site were being met. Using knowledge gained through research and community input, the project team was able to create, evaluate, and recommend two potential designs for the Flint Road Recreational Complex for the Town to choose from.

Background

In order to begin to create a new site plan for the Flint Road Recreational Complex, one must understand the history behind the project, the design specifications, and the constraints of the property.

The History of the Flint Road Recreational Complex

On May 16th, 2005 the Charlton Recreation Commission was authorized by the Town of Charlton to begin work on a new recreational complex on Town-owned land on Flint Road to meet the need of Charlton's Youth Sports Programs (Charlton Recreation Commission, 2007).

After permission was granted by the Town, the Recreation Commission hired Gwen Krevosky from EBT Environmental to locate the property lines, conduct a topographic survey of the land, and delineate the wetlands (Gauvin, 2010). The Recreation Commission was then able to determine the useable space and hire BSC TerraSphere to prepare a Master Plan for the site. The company revised their original site design six times, before the project came to a halt in 2007 due to the creation of the new Department of Public Works highway facility on the Flint Road lot (Fanger, 2007). This came to a halt because other projects were of higher priority than creating a new site design.

In the summer of 2010, work on the Flint Road Recreational Complex was restarted by the Town's Recreational Committee with the help of the WPI Project Team. In order to move forward with the construction of the site, Scott Garish who was performing the tree clearing work for the highway facility secured a contract with the Recreational Committee. Figure 1 shows the upper northeastern side of the site near where the new facility will be constructed, after some trees were removed. By clearing part of the Flint Road site at the same time as preparing for the construction of the Highway facility, the Town was able to save some money and time (Gauvin, 2010).

Figure 1: Tree Clearing of Northeastern Side of the Parcel

Original Site Plans

To more fully understand the motivators and ideas contributing to this process the project team investigated why the company BSC TerraSphere made edits to the conceptual design. Figure 2 shows BSC TerraSphere's first conceptual design created in January of 2007. The design includes a multi-purpose field with surrounding track, two little league fields, a senior league field, and a practice field.

Created in August of 2007 Figure 3 shows the same multi-purpose field with surrounding track and senior league field. Instead of two little league fields, the Town decided it would be in their best interest to create, if possible, a men's softball field and a little league field. The only change that this brings is that the softball field will be fifty feet longer than the little league field and take up more overall space. A second change between Figure 2 and 3 is the removal of a practice field, with the hope that a practice field could be overlaid in the outfield of the senior league baseball field. The senior league field at the bottom right side of Figure 3 shows this overlay. Also with potential sports summer camps in mind, a basketball court was added to the parcel.

The road layouts between the two figures are very similar with the only difference being the location of the roadway. In Figure 2 the road travels along the eastern side of the little league field while in Figure 3 the road travels on the western side of the field. In Figure 3 the

parking has been increased to 335 spaces from 219 in Figure 2 to accommodate more people by request of the Town.

The original design incorporated an outline of the necessary field components. These components were included in the final BSC TerraSphere design and are to be included in the project team's designs. The components deemed necessary include the Senior League Baseball Field, Little League Baseball Field, the multi-use athletic field, concession stand and pavilion, and a basketball court.

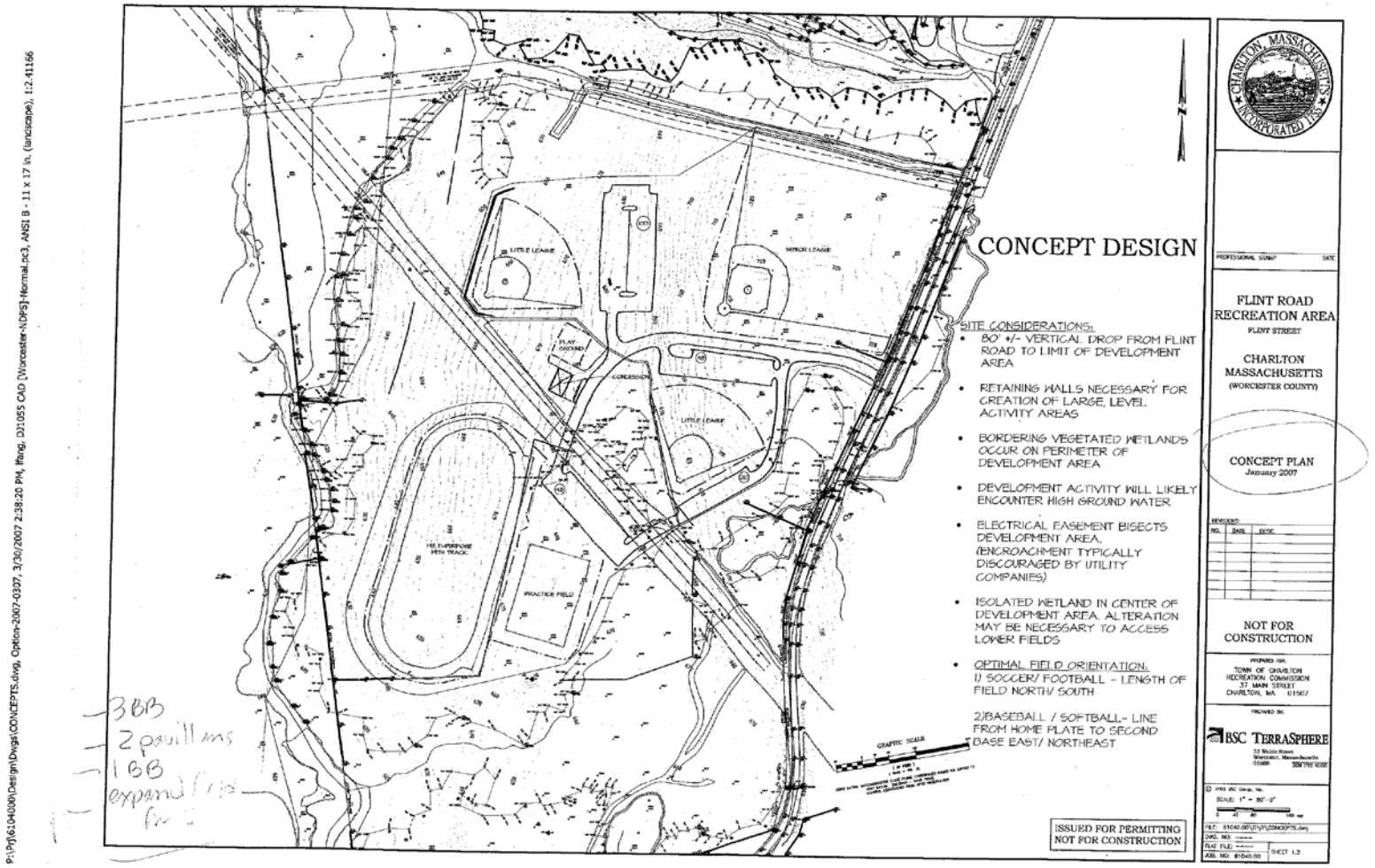


Figure 2: BSC's First Conceptual Design (January 2007)

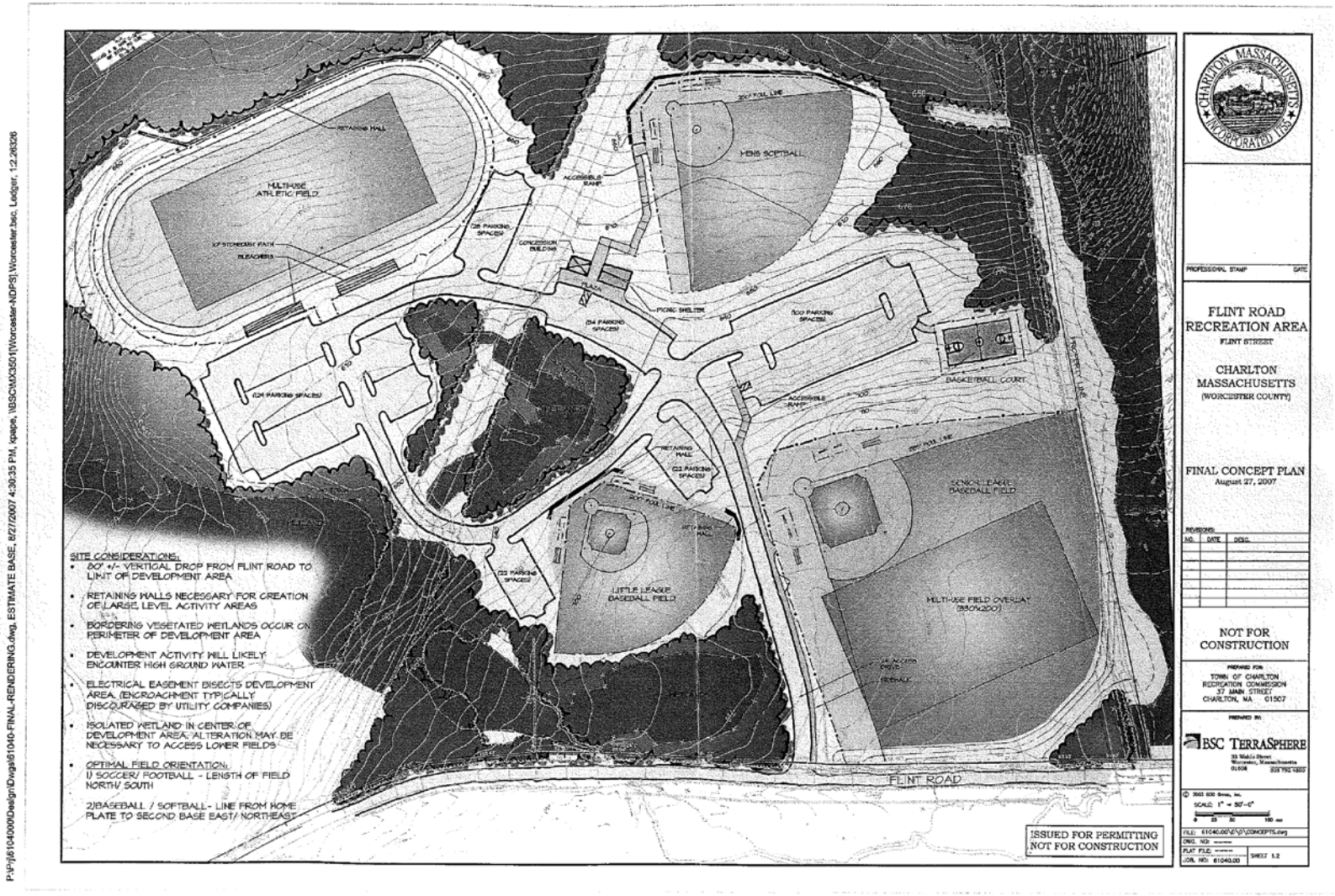


Figure 3: BSC's Most Recent Conceptual Design (August 2007)

Parcel Boundaries

The Department of Public Works will be using more than two and a half acres to build a new facility. This loss of assumed usable land requires a new Master Plan to reconfigure the plans of the recreational complex so that all the necessary components fit onto the site. In order to reconfigure the layout of the site, the Project Team needed to map out the actual property. The current land parcel is estimated in Figure 4.

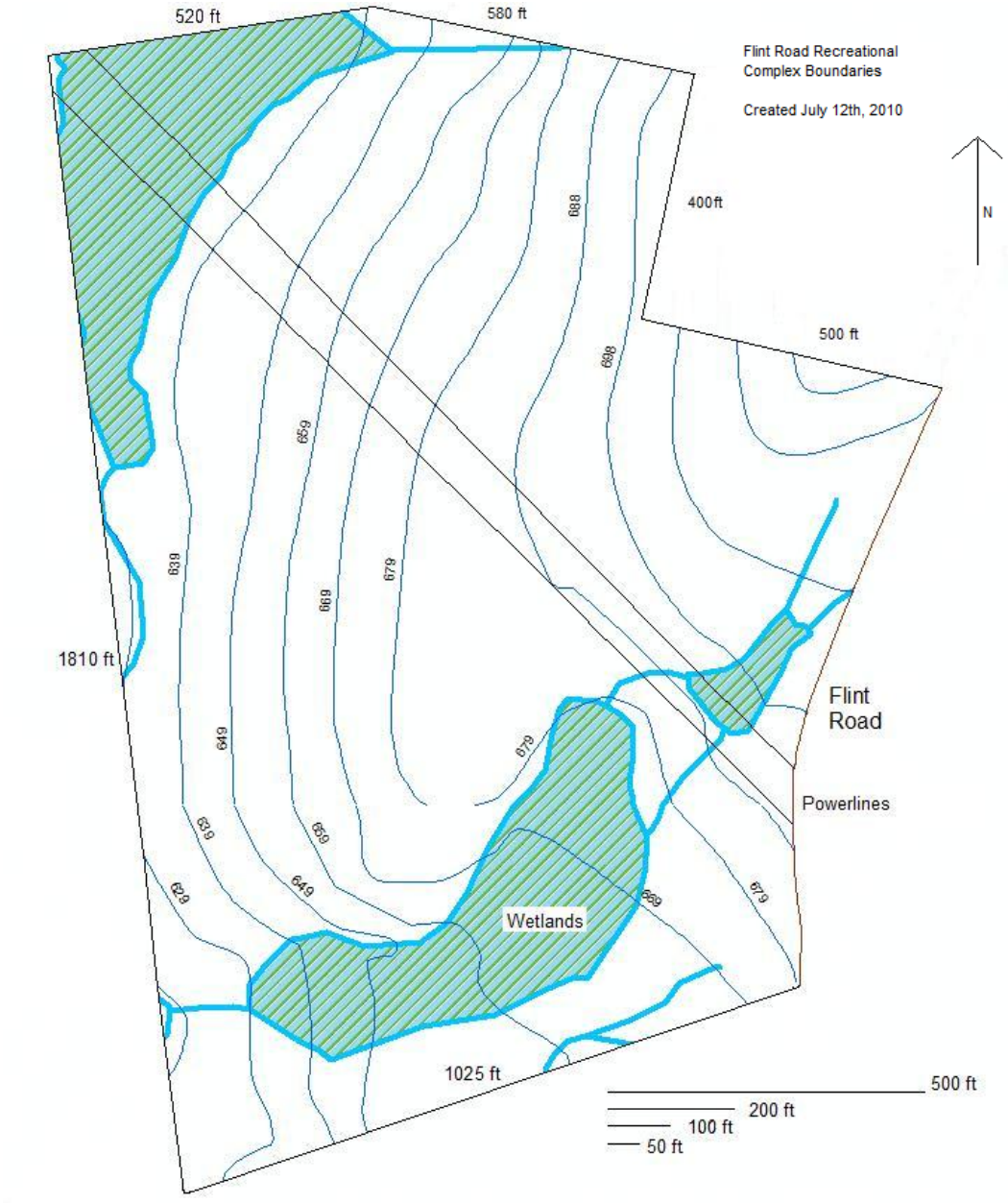


Figure 4: Parcel Boundaries

Constraints of the Property

Physical Constraints

The physical limitations from the power lines, wetlands, and the elevation change of the site make design difficult. Within the site boundaries the land will need a lot of cut and fill to be of use. Cut and fill brings concerns to any project such as roadway safety, proper drainage, and the ability to construct flat playing fields. Of the restricted land available, the flattest area was unable to be used for the Recreational Complex, due to the construction of a new Department of Public Works building.

Power Lines

The Flint Road Recreational Complex site is bisected by power lines from the National Grid. In order to develop the land under the power lines, the Town of Charlton needs to go through a process called "Property Transaction Review." In this process Charlton would have to submit a series of drawings illustrating the proposed changes and construction within the right of way (ROW) of the power lines (Farrell, 2010). Representatives from National Grid's real estate department along with its forestry, transmission planning, and various legal departments will all evaluate the proposed changes and vote on whether or not to grant permission for the construction.

When looking at the proposed construction, National Grid looks at many factors including…

- New grading should not significantly reduce the clearance to ground of the conductor
- If so, the clearance to ground should be compliant with the Massachusetts 220 CMR 125 governing code
- No storage, structures, or loading/unloading areas within the ROW.
- Any fences grounded should be per IEEE Standard 80.
- No excavation is allowed within a fifty foot radius of existing structures.
- No explosives should be used during construction.

- Access to structures and ROW must be preserved, and existing access should not be damaged.
- Mature vegetation heights of plantings must be kept below 8ft in potential construction work areas and less than 14 feet in areas accessible to vehicles.

Wetlands

Wetlands are defined as "transition zones where the flow of water, the cycling of nutrients, and the energy of the sun meet to produce a unique ecosystem characterized by hydrology, soils, and vegetation." (EPA, 2004) It is important to note that wetlands may not be wet year-round; the amount of water present often changes with the season. In the United States there are four categories of wetlands: marshes, swamps, bogs, and fens. The type of wetland on the Flint Road site is swamps.

The Town of Charlton hired a surveyor to delineate the wetlands on the Flint Road site which were found mainly in the southeastern part of the parcel. The Conservation Commission of Charlton would like to keep as of much the wetlands intact as possible (Gauvin, 2010). This is to preserve them and potentially save the Town money by using the natural wetlands as a storm water management system. It is the responsibility of the Conservation Commission to protect these wetlands under the Massachusetts Wetlands Protection Act (MassDEP, 1997). The wetlands will be surrounded by a twenty-foot buffer zone.

The Clean Water Act of 1972 created a foundation for the management and regulation of water pollution in the United States (EPA, 2009). The Act gave the EPA the authority to implement the National Pollutant Discharge Elimination System (NPDES) to monitor and regulate storm water runoff. Even though the EPA is a federal authority, some states have their own policies in place to address storm water management. However, in Massachusetts the EPA is the permitting authority which means that the project team must obey the laws, regulations, and guidelines set by the EPA. The Flint Road Recreational Complex will need to follow these EPA guidelines, which will affect how the complex is designed so that it can handle storm water properly.

Sports Fields Design Criteria

Baseball and Softball

According to Sports Fields: A Manual for Design, Construction and Maintenance, a sports manual that has been called by Athletic Turf News "a definitive how-to book for sports field managers", when designing baseball and softball fields the best design is to make the field slightly contoured to deal with standing water. The sloping gathers the surface water from the fields and channels it to the appropriate water basins. Without sloping, water will help destroy a field if play on the field continues during standing water, because grass roots are easily torn while submerged in water. If the field is too damaged to continue playing, sod will have to replace the destroyed field, which can get expensive for the field manager. The optimal field orientation for a baseball or softball field is to have the line between home plate and second base run east to northeast. This optimal orientation is based on usage and keeping the sun out of as many players eyes as possible. Table 1 presents the size of each field.

The first of three options shown in Figure 5 includes sloping the outfield downward away from the base lines in about a 1% grade. The advantage to this design is the ease of construction due to the fact that the entire outfield is in a uniform 1% slope. The disadvantage is that the outfield fence is about 3ft lower than the base paths leading to more homeruns and a harder to defend outfield, meaning the team at bat has an unfair advantage. The second option shown in Figure 6 is a crowned approach from second base to the middle of center field at the outfield fence. This approach directs water away from the field at a shorter distance and away from the center of the field. The third option shown in Figure 7 is another crowned approach in which the crown is located about 1/3 of the distance from second base to the outfield fence. This has the advantage of efficient runoff, having the shortest distance for the water to flow, and also having the outfield fence at the same level as the base paths.

Table 1: Baseball Field typical specifications (Pulhalla)

Field	Dimensions	Sq. ft.	Acreage
Senior League Baseball Field	400'+ foul line	195,000	4.5
Little League field	200'+ foul line	60,000	1.4

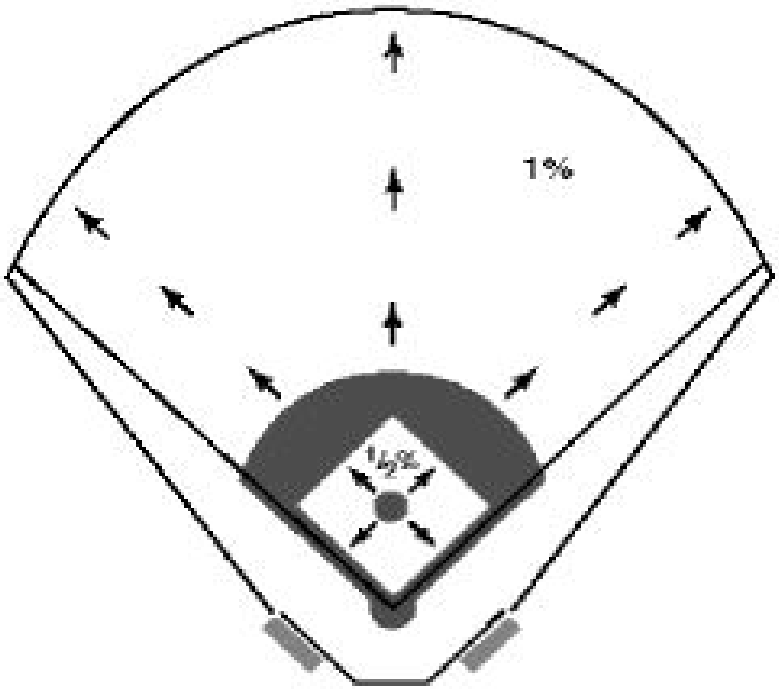


Figure 5: Option 1 for Baseball fields

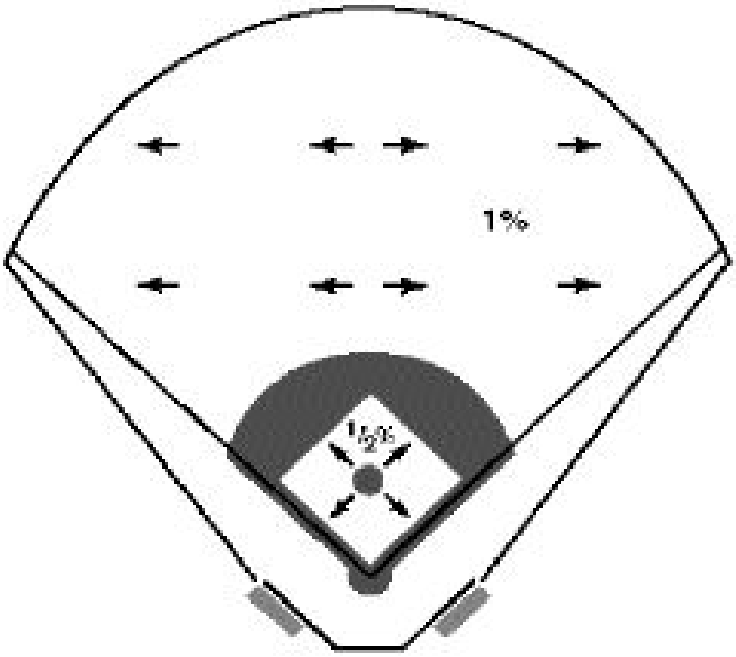


Figure 6: Option 2 for Baseball fields

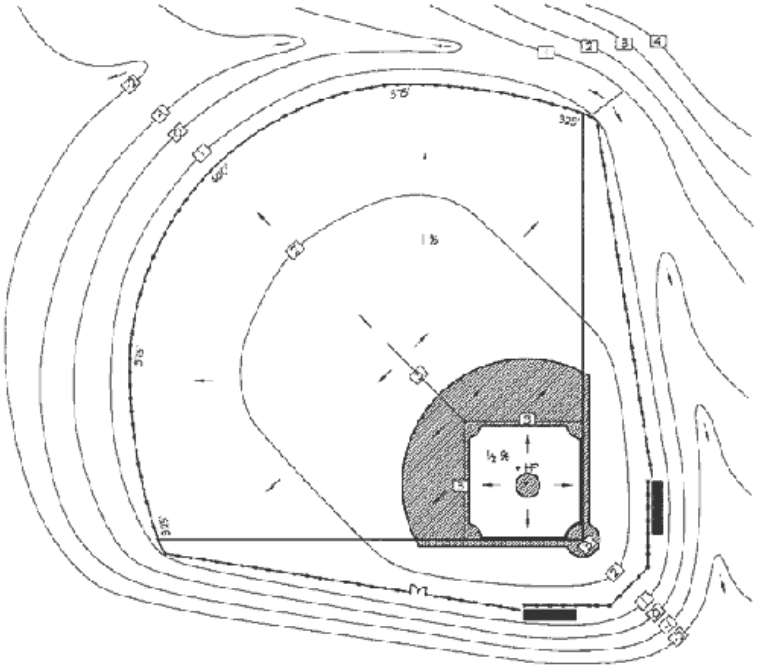


Figure 7: Option 3 for Baseball fields

Football Field and Track

The optimal field orientation for a football field is a north-to-south direction, to specifically avoid glare from the sun during games. The field is also crowned along the longitudinal center line to allow for the most favorable drainage. For a NFSHSA (National Federation of State High School Associations) accepted football field the total length should be 360' and have a width of 160'. As this field will be multi-use the project team must take into consideration soccer field standards, which according to the NFSHSA must be between 165'x300' and 225'x360'. Also the surrounding track normally is a quarter mile oval split into a quadrant with two 100-meter straight-aways and two 100-meter curves at either end. These dimensions are outlined in Table 2.

Table 2: Football field and track desired specifications

Field/track	Dimensions
Football	160'x360'
Soccer	195'x300'
Track	¼ mile oval

Lighting

In this design the project team has identified two fields to have lighting for nighttime use, the senior league baseball field and the turf multi-use field. According to MLB.com's field maintenance guide, the major league baseball official website and baseball field maintenance guide, a high school or youth competitive field level should have 50 Foot-Candles for the infield and 30 for the outfield evenly distributed to prevent glare(MLB.com, 2006). Foot-Candles are the measurement used for lighting in the U.S.; in Europe, lights are measured in Lumens. In order to use the turf multi-use field for competition and accommodate some spectator seating, a minimum average number of foot-candles is 30 (US Soccer Foundation, 2007). The fields can be illuminated with either a 4-pole configuration shown in Figure 8 or a 6-pole configuration

shown in Figure 9. The US Soccer Foundation also declares “Galvanized steel poles are the recommended structure because the hot-dip galvanizing assures that the pole is protected on the inside as well as the outside from corrosion” (US Soccer Foundation, 2007). The four-pole system will cost less but provide lower quality lighting. The 6-pole system would produce more consistent field coverage by having more lights but cost more for the extra two poles. It is also recommended that the steel poles be padded for safety reasons.

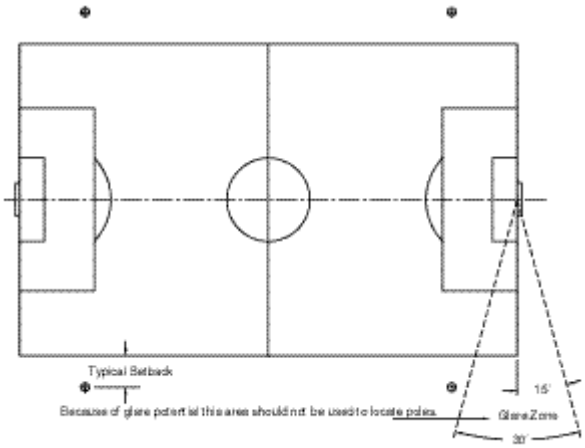


Figure 8: 4-Pole Configuration for lighting

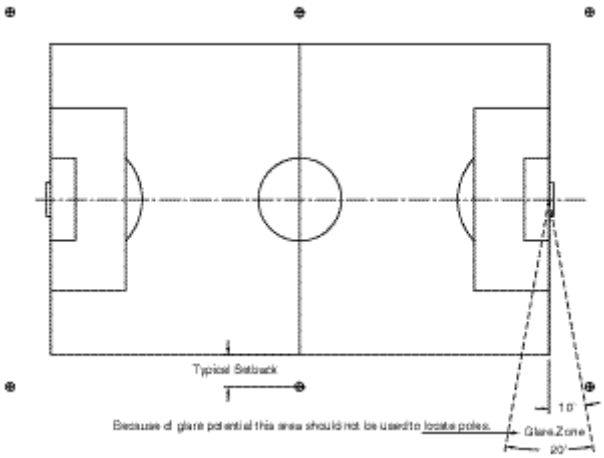


Figure 9: 6-Pole Configuration for lighting

Parking

The Massachusetts Government and the Town of Charlton have no formal requirements for parking. If the Town of Charlton was to adopt a parking requirement an example of what it

could look like follows: “For places of public assembly, including libraries, museums, clubs, restaurants, theaters, bowling alleys and other amusement centers, funeral establishments, trade schools and bus depots - one (1) parking space for each four (4) seats or, where benches are used, one (1) space for each eight (8) lineal feet of bench. Where no fixed seats are used (as in a museum), there shall be one (1) parking space provided for each 80 square feet of public floor area” (Mass.gov, 2010). This means that the minimum number of parking spaces needed for the Flint Road Recreational Complex is 162 spaces. This number came from dividing the number of planned spectator seating by 4. To adequately fit a car into a space the following requirement will have to be planned for, “Parking areas shall be clearly delineated and shall be provided with a permanent dust-free surface and adequate drainage. Each parking space shall be at least 9 feet x 18 feet in size, and all parking areas must have adequate access and maneuvering areas” (Mass.gov, 2010). These requirements are necessary to any planning design. Insufficient parking would result in a large magnitude of complaints and unhappy community members.

Road Components

The road layout must be designed to account for easy flow of traffic and navigation. Any possible layout must require a way to incorporate fast and easy travel for emergency vehicles.

The Rules and Regulations governing the subdivision of land in Charlton, Massachusetts states four requirements regarding road slopes. These four requirements are identified for the safest construction and planning of the road system.

(a) Grades of all streets shall be the reasonable minimum, but shall not be less than three-fourths (.75) per cent.

(b) The maximum center line grades shall be as follows:

Minor streets: ten (10) per cent.

Collector streets: eight (8) per cent.

Major streets: six (6) per cent.

(c) All changes in grade exceeding three-fourths (.75) per cent shall be connected by vertical curves of sufficient length to afford, in the opinion of the Board, adequate sight distances.
(d) On any street at the approach to an intersection, a leveling area shall be provided having not greater than three-fourths (.75) per cent grade for a distance of twenty-five (25) feet measured from the nearest right-of-way line of the intersecting street.

Loop Design

Design of a road with a loop system has many advantages. The major advantage is in the flow of traffic it creates, making it easier to navigate and safer for community members. Another advantage it creates is the ability to not have to worry about emergency or service vehicles, as they will be able to make their way out without delay.

Cul-de-sac Design

There are many alternatives to a dead end road, such as a T-shaped turnaround and cul-de-sac. The easiest way to turn around is a cul-de-sac because a T-shaped turnaround requires a three point turn for most vehicles. The benefits of having a cul-de-sac include the ability to incorporate flow of traffic and "accommodate the turning radius of most emergency, service, and maintenance vehicles" (Metro Council, 2008). The Metropolitan Council is the regional planning agency serving the Minneapolis – St. Paul metropolitan area in Minnesota. The Metropolitan Council also recommends "A landscaped island can be created in the center of the cul-de-sac, where driving does not occur. This island can be designed as a depression to accept stormwater runoff from the surrounding pavement, thus furthering infiltration. A flat apron curb will stabilize roadway pavement and allow for runoff to flow into the cul-de-sac's open center". Metro Council also comments that "Cul-de-sac designs like those suggested here result in less stormwater runoff requiring management and less impact on downstream water bodies" (Metro Council, 2008).

Stormwater Management

Stormwater runoff is precipitation from rain or snow that does not percolate back into the ground due to impervious surfaces such as buildings and pavement (EPA, 2010). When the runoff flows over these buildings and pavements, it collects debris, chemicals and other

pollutants along its way. It is then that the stormwater runoff becomes contaminated and if not directed correctly, the runoff may become a problem and flood and/or pollute the surrounding wetlands and natural habitats. Table 3 is taken from the Massachusetts Department of Environmental Protection and Office of Coastal Zone Managements' Stormwater Management Handbook and shows what the sources of Stormwater pollutants are and their impacts (MA Department of Environmental Protection and Office of Coastal Zone Management, 1997).

Table 3: Stormwater Pollutants, Sources, and Related Impacts (MassDEP, MA Office of Coastal Zone Management, 1997)

Stormwater Pollutant	Sources	Related Impacts
Nutrients: Nitrogen, Phosphorous	Urban runoff, Animal waste, Fertilizers, Failing septic systems	Algal growth; reduced clarity; lower dissolved oxygen; release of other pollutants
Solids: Sediment (clean and contaminated)	Construction sites, Other disturbed and/or non-vegetated lands, Eroding banks,	Increased turbidity; reduced clarity; lower dissolved oxygen; deposition of sediments; smother aquatic habitat including spawning sites; sediment and benthic toxicity
Pathogens: Bacteria, Viruses	Animal waste, Urban runoff, Failing septic systems	Human health risks via drinking water supplies; contaminated shellfish growing areas and swimming beaches
Metals: Lead, Copper, Cadmium, Zinc, Mercury, Chromium, Aluminum, others	Industrial processes, Normal wear of automobile brake lines and tires, Automobile emissions, Automobile fluid leaks, Metal roofs	Toxicity of water column and sediment; bioaccumulation in aquatic species and through food chain
Hydrocarbons: Oil and Grease, PAHs (Naphthalenes, Pyrenes)	Industrial processes, Automobile wear, Automobile emissions, Automobile fluid leaks, Waste oil	Toxicity of water column and sediment; bioaccumulation in aquatic species and through food chain
Organics: Pesticides, PCBs, Synthetic chemicals	Pesticides (herbicides, insecticides, fungicides, rodenticides, etc.), Industrial processes	Toxicity of water column and sediment; bioaccumulation in aquatic species and through food chain
Salt: Sodium, Chlorides	Road salting and uncovered salt storage	Toxicity of water column and sediment

For the Flint Road Recreational Complex the sources of stormwater runoff were construction sites, automotive wear, and road salting with the potential for pesticides and fertilizers for the maintenance of the fields, dependent upon what type of products the Town wished to use on site.

There are many ways to assist in managing stormwater runoff, and they are categorized under nonstructural and structural Best Management Practices (BMP). Nonstructural BMPs mainly deal with manipulating the design and layout of a site. This may include reducing the footprint of a building by making it taller so that it may take up less pervious ground, hence reducing the amount of stormwater runoff. Structural BMP however, are physical structures like swales and basins that help to manage the runoff (MA Department of Environmental Protection and Office of Coastal Zone Management, 1997).

Permits and Regulations

According to Charlton's Permitting Guidebook and Federal Regulations, a Storm water Notice of Intent or a NPDES permit is needed when "construction activity including clearing, grading and excavation activities" exceeds five acres except operations that result in the disturbance of less than five (5) acres of total land area, which is part of a larger common plan of development or sale." (Town of Charlton, 2008). The Town's Permitting Guidebook follows Massachusetts Wetalnds Regulations which require the Notice of Intent (NOI) which must be filled out by the owner/operator of the site (Massachusetts Department of Environmental Protection, 2010). The developer must get the site plan approved from the Massachusettes DEP. For a successful construction project the proper channels should be taken. The following permits and regulations will need to be completed before construction begins.

NPDES

This stormwater regulatory permit is defined for "Construction activities (which include soil disturbing activities such as clearing, grading, excavating, stockpiling, etc.) that disturb one or more acres, or smaller sites that are part of a larger common plan of development or sale, are regulated under the NPDES stormwater program. Operators of regulated construction sites are required to develop stormwater pollution prevention plans; to implement sediment,

erosion, and pollution prevention control measures; and to obtain coverage under a state or EPA NPDES permit" (MassDEP, 2010).

WPA Form

The WPA form has been created to preserve wetlands in Massachusetts. "To protect the Commonwealth's wetland resources, the Massachusetts Wetlands Protection Act (General Law Chapter 131, Section 40) prohibits the removal, dredging, filling, or altering of wetlands without a permit. To obtain a permit (called an Order of Conditions), a project proponent must submit an application to the Conservation Commission and the Department of Environmental Protection (the Department)" (MassDEP, 2010).

Disposal System Construction Permit

This permit is to gain approval to begin construction of a new septic system. The permit ensures "The construction and maintenance of the on-site sewage disposal system in accordance with the provisions of Title 5 of the Environmental Code of Massachusetts and not to place the system in operation until a Certificate of Compliance has been issued by the Board of Health" (MassDEP, 2010). To gain this permit an application must be filled out and submitted to MassDEP.

Drinking Water Forms

To comply with the Bureau of Resource Protection of Massachusetts a permit for supplying water is needed. This permit will include distribution modifications to serve either at most 3,300 people (BRP WS 33) or more than 3,300 people (BRP WS 32).

Americans with Disabilities Act

The Americans with Disabilities Act has been created to address problems with accessibility. Compliance with the Americans with Disabilities Act is mandatory for all new construction projects. The impact that this brings to the Flint Road Recreational Complex is in creating ramps instead of stairs if possible and providing wheelchair seating in each spectator area. Curb ramp slopes are outlined in Figure 10, and the amount of required wheel chair locations are summarized in Table 4 (Department of Justice, 2010).

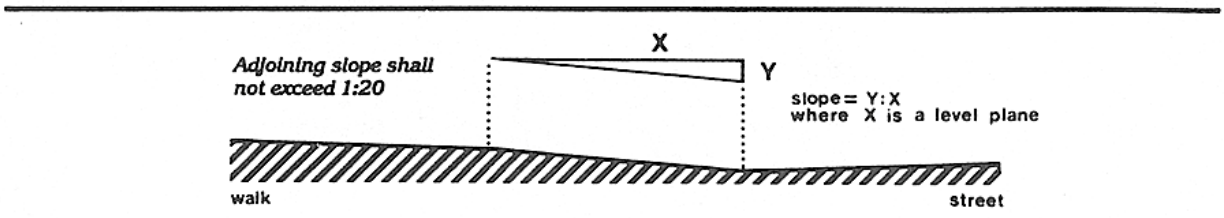


Fig. 11
Measurement of Curb Ramp Slopes

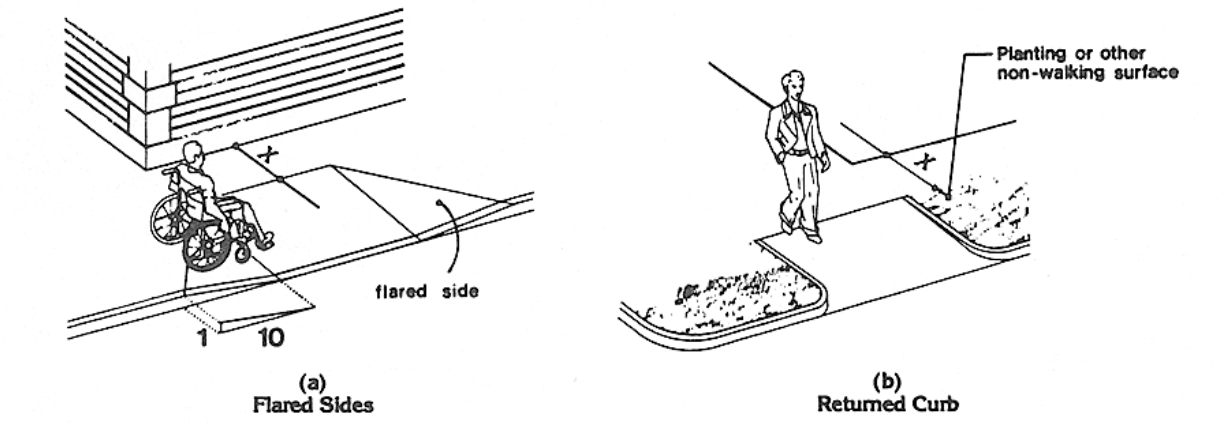


Fig. 12
Sides of Curb Ramps

Figure 10: Curb Ramps Design (Department of Justice, 2010)

Table 4: Required Number of Wheel Chair Locations (Department of Justice, 2010)

Capacity of seating in Assembly Areas	Number of required wheel chair locations
4-25	1
26-50	2
51-300	4
301-500	6
500+	6+1 for every extra 100 people

Methodology

Background Information

Background information was collected through research and interviews with the Town Conservation Agent, Karen Gauvin. Information was also collected through contact with Leslie Fanger of the BSC Group and Jessica Farrell of National Grid.

Site Visits

To fully understand the challenge posed by creating sports fields on a slope the project team took a trip to visit local fields. These local fields include the College of the Holy Cross's multi-use fields, and Becker College's football field. The five College of the Holy Cross's fields are all based at small elevation changes and the field at Becker College was built into an extremely steep slope. Appendix A shows pictures from both locations.

Generation of Land Map

ArcGIS is a Geographic information system that "allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts." (ESRI, 2010) By using this program and an assortment of its data, which included roads, streams, wetlands, and contour lines, the project team was able to identify existing conditions of the property as well as characteristics that might constrain development. Using the layout the project team was able to gain a better understanding of land available and the land restrictions. This map is shown in Figure 4.

Cut and Fill

The Flint Road Site has a total elevation change of 80ft over roughly 45 acres. Figure 11 shows a 3D image of the contour lines and the theoretical fill available under the site. The highest part of the site is found in the Northeastern corner and the lowest is located in the Southwestern corner.

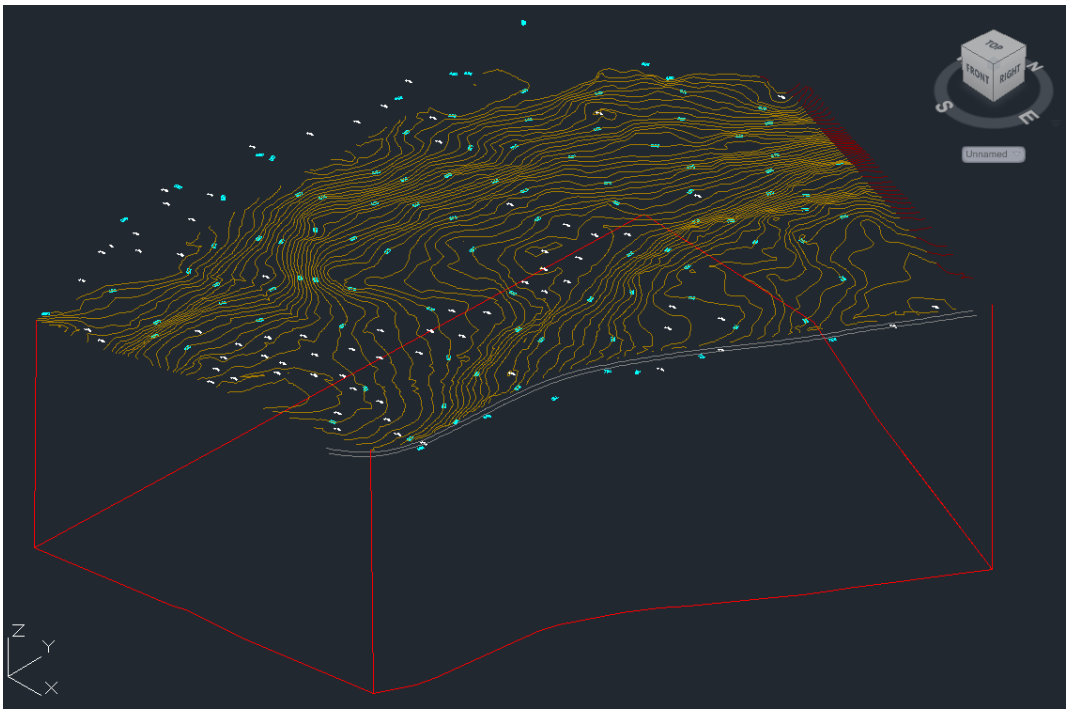


Figure 11: 3D Contour Lines of the site

In order to make general estimations for cut and fill quantities the project team had to identify the preferred elevation for each area. This elevation was determined by finding the average elevation over the area of the given field. Once this elevation was identified, the project team could move ahead with the estimations. To create the estimations the project team split each region into sections while creating simplified triangles above and below the preferred elevation. With the simplified triangles the project team was able to find the area and multiply that by the length of the section. After calculating the areas and depth quantities the project team was able to sum the cut and fill for the site as a whole and each field individually.

Use of AutoCAD

AutoCAD was created by Autodesk and stands for Auto Computer Aided Design. The project used this program extensively to create both of the design proposals. AutoCAD gives the user the ability to view the property and gain a better understanding of the project. The program allows for the insertion of contour lines and boundary lines. Using manually inserted distances and figure sizes the project team was able to successfully create the two new design proposals.

Analysis of Design Options

Creation of Conceptual Design Options

By identifying boundaries, constraints, and restrictions the project team was able to create two conceptual designs for the Flint Road Recreational Complex. Both of the designs include road access, field layout, cut and fill estimation, and other specific design requirements.

Design Proposal 1

The project team, using Town information, recreated the layout shown in Figure 3 using AutoCAD software. Figure 3 is the design from BSC TerraSphere before the boundary had been altered due to the Department of Public Works building construction. The first design proposal shown in Figure 12 contains two baseball fields, a 200' little league baseball field and a 400' senior league baseball field, a turf full length multi-use sport field surrounded by a quarter mile track, a basketball court, parking, and a concession stand with a pavilion. By request of the Town, the little league field in the northwest corner was removed and replaced with the senior league field that no could longer be accommodated along with the Department of Public Works facility. The only other change from the second BSC TerraSphere design is the shifting of the parking lot in the northern section of the parcel, to make room for the larger senior league field.

The strategy behind the layout of this design was to keep the site plan as close to Figure 3 as possible. This way, the Town could have almost all of the components of their original design, but accommodate the space for the highway facility.

Cut and Fill

Due to the unique and challenging contours of the Flint Road site, the project team decided to create a multi-level complex. This multi-level design will help to alleviate the amount of cut and fill needed for the site compared to if the whole complex graded to the same elevation.

The team used visual estimation based on the contour lines and where the fields were positioned on the site to establish a target elevation for each field. Based on each field's elevation in relation to one another, the project team split Design Proposal 1 into four different levels. Level one was the basketball court at the 713 ft. elevation. Level two was the little

league baseball field along with its two adjacent parking lots at the 700 ft. elevation. Level three was the senior league baseball field with its parking lot at the 680 ft. elevation. And finally at level four, the athletic field was positioned at the 655 ft. elevation. Table 5 shows the breakdown of the cut and fill quantities for each level in Design Proposal 1.

Table 5: Design Proposal 1 Cut and Fill Breakdown

Design 1	Highest (ft.)	Lowest (ft.)	Average (ft.)	Field Level (ft.)	Cut (ft^3)	Fill (ft^3)	Net Total
Level 1: Basketball Court	716	711	713.5	713	7,980	-7980	0
Level 2: Little League Field	712	687	699.5	700	212,181	-118,645	93,536
Level 3: Senior League Field	710	650	680	680	1,642,560	-1,448,640	193,920
Level4: Track and Field	670	626	648	655	1,068,406	-1,076,400	-7994
							279,462

Based on the steepness of the contour lines, the location of the fields and their distances from other site components, the project team estimated that for Design Proposal 1 only one large retaining wall will be needed on the southwestern border of the multi-use athletic field.

Road layout

The road layout will remain the same as proposed in Figure 3, the original site plan, to generate safe parking and car flow. The road will connect to Flint Road perpendicularly, creating an ease of entrance and exit catering to both directions on Flint Road. The two-way access road will connect to a one-way loop that leads to all parking and all field entrances. The one-way circle is designed to minimize conflicting vehicle movements for safer travel. The width of the road will also remain the same as Figure 3 at 24’ across.

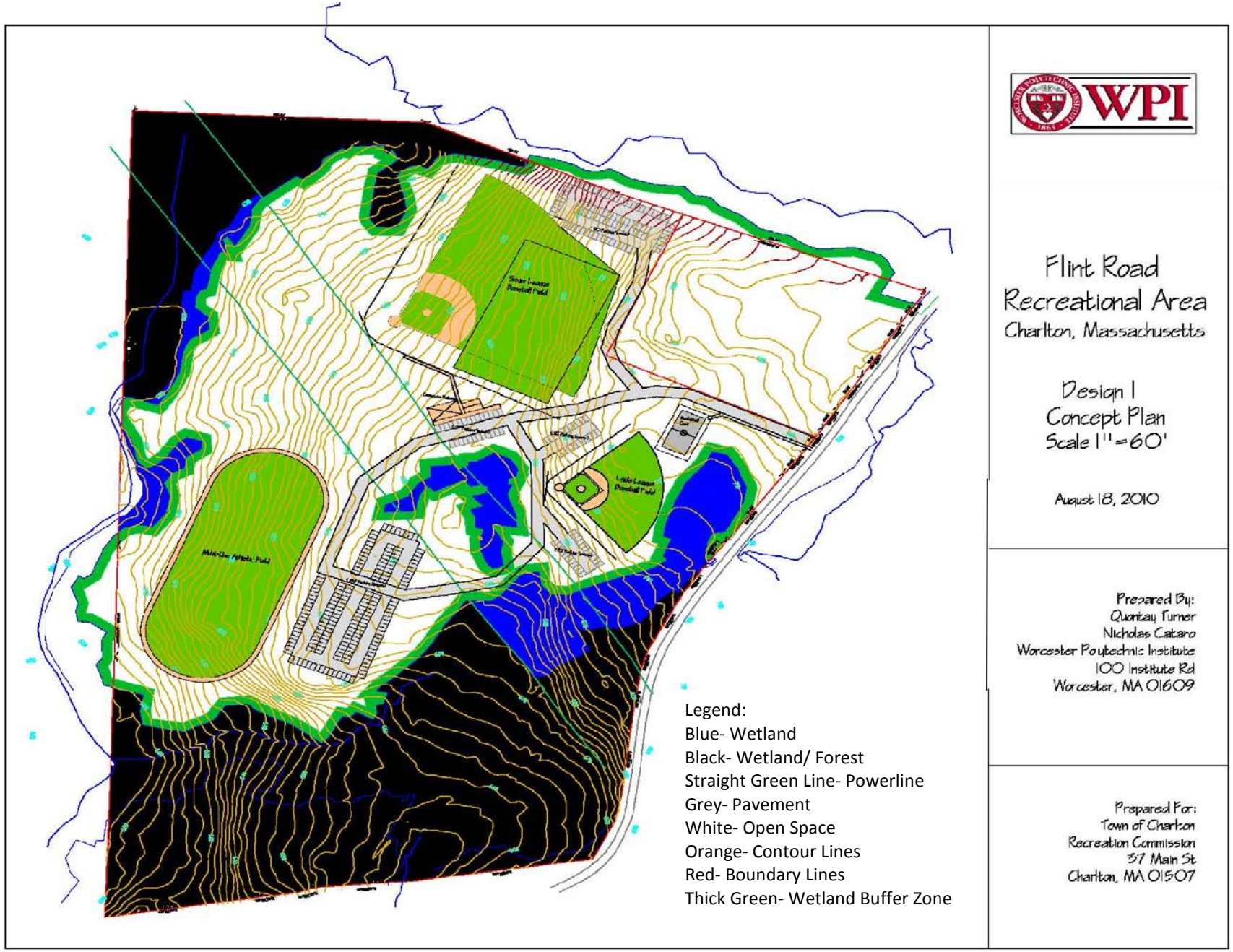


Figure 12: Design Proposal 1

Design Proposal 2

The project team's second design proposal shown in Figure 13 contains three baseball fields-- a 200' little league field, a 250' men's softball field, and a 400' senior league baseball field; a turf full length multi-use sport field surrounded by a quarter mile track; a basketball court; 264 parking spaces; and a concession stand with a pavilion. The project team redesigned the land parcel to fit all fields originally included in BSC TerraSphere's design shown in Figure 2. To create a design that can accommodate all fields and sufficient parking the project team has replaced from Design Proposal 1 the senior league baseball field with the full length multi-use sport field surrounded by a quarter mile track. In the location where the sport field was is now the little league baseball field, and senior league baseball field with a practice sport field overlay. In the little league field position is now the men's softball field. The softball field was removed from Design Proposal 1 because it was a lower priority than the senior league field and turf.

Cut and Fill

Using the same multi-level method as in Design Proposal 1, the project team determined based on Design Proposal 2's field locations that three levels would be best suited for this design.

Level one was the men's softball field and its adjacent parking lot at the 706 ft. elevation. Level two was the athletic field, the basketball court and their parking lots at the 685 ft. elevation. And Level three was the senior league baseball field at the 655 ft. elevation. Table 6 shows the breakdown of the cut and fill quantities for each level in Design Proposal 2.

Table 6: Design Proposal 2 Cut and Fill Breakdown

Design 2	Highest (ft.)	Lowest (ft.)	Average (ft.)	Field Level (ft.)	Cut (ft^3)	Fill (ft^3)	Net Total
Level 1: Softball Field	716	688	702	706	167,207	224,837	-57,630
Level 2: Athletic Field	714	656	685	685	1,036,597.5	-1,067,887	-31,289
Level 3: Little and Senior League Field	680	636	658	655	1,558,869	-1,128,622	430,247
							341,328

With this orientation of the fields in respect to the steepness of the contour lines and the distance the fields are away from other site components, the project team estimated that for this design one large retaining wall will be needed outside of the foul lines of the senior league baseball field.

Road Layout

The road layout for Design Proposal 2 is much different than that of Design Proposal 1. Due to the fact that the larger men's softball field takes up the space needed to keep the road loop intact, a dead end two-way road will service the facility ending with a cul-de-sac to reverse direction. This cul-de-sac will be large enough for any bus or emergency vehicle to easily turn around with a radius of 40' and a road width of 24'. Within the cul-de-sac there will be no parking permitted to guarantee the necessary turn around space for busses and emergency vehicles.

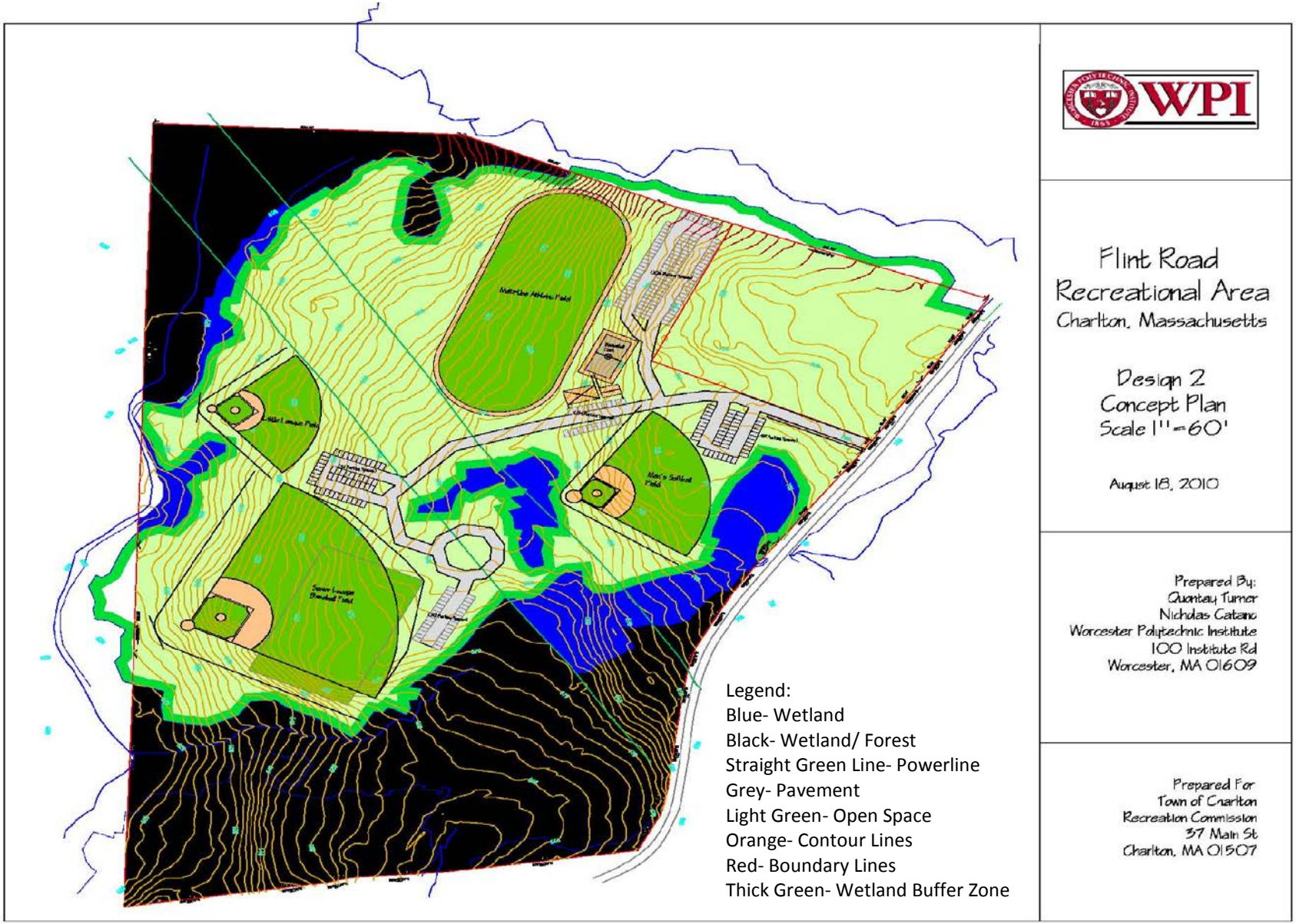


Figure 13: Design Proposal 2

Estimation of Costs

The original cost for the entire Recreational Complex set back in August of 2007 was $3,459,500.00. This estimate differs from Design Proposal 1's at $3,291,810.00 and Design Proposal 2's at $3,301,730.00. A breakdown of the original cost estimation, Design Proposal 1's cost estimation and Design Proposal 2's cost estimation is shown in figures 7, 8, and 9 respectively. The main difference between the original estimate and the two Design Proposal estimates is from the two and half acres that was given to the highway facility, which was originally part of the complex. The major cost difference between the two Design Proposals was that Design Proposal 2 included the softball field, making the cost slightly larger than that of Design Proposal 1 which did not include the softball field.

All of the designs were scheduled to be constructed in two phases. For the original design and Design Proposal 2 the first phase included the construction of the parking lots along with the softball, little league, and senior league fields. For Design Proposal 1 the first phase included the construction of the parking lots with the little league and senior league baseball fields. The second phase for all of designs included the multi-use athletic field with parking and the concession building. The reason for constructing the complex in phases was to help alleviate the upfront costs by saving the most expensive section, the multi-use athletic field, for last.

Completing the project in phases not only saves on upfront costs but saves on the total costs of constructing the entire complex. Each level of the complex in a given design needs a certain amount of cut or fill to be constructed. In Design Proposal 1 the excess cut from the little league and senior league field is needed to construct the athletic field. In Design Proposal 2 the cut left over from constructing the little league and senior league field is needed to construct both the softball and athletic field. By using the cut and fill from the different levels of the complex, the Town saves money by not having to bring in fill from off site to complete construction. Design Proposal 1and 2 will actually have left over soil of 279,462ft^3 and 341,328 ft^3.

Table 7: Charlton's 2007 Cost Estimates

Phase I			**Original Design**		
Amenities	Dimension		Cost Per Unit	Cost	Subtotal
Site Preparation					
Mobilization				$ 7,000.00	
Tree Clearing and Grubbing	11	Acres	$ 8,000.00	$ 88,000.00	
Rough Grading	11	Acres	$ 7,000.00	$ 77,000.00	
TOTAL				$ 172,000.00	$ 172,000.00
Little League	200'	Outfield			
Ball field				$ 130,000.00	
Bleachers	84	Spectators		$ 2,500.00	
Irrigation				$ 35,000.00	
TOTAL				$ 167,500.00	$ 167,500.00
Men's Softball	250'	Outfield			
Ball field				$ 150,000.00	
Bleachers	84	Spectators		$ 2,500.00	
Irrigation				$ 35,000.00	
TOTAL				$ 187,500.00	$ 187,500.00
Senior League Baseball (Multi-Purpose Field in Outfield)	400'	Outfield			
Ball field				$ 200,000.00	
Bleachers	240	Spectators		$ 16,000.00	
Lighting				$ 210,000.00	
Irrigation				$ 35,000.00	
TOTAL				$ 461,000.00	$ 461,000.00
Basketball Court					
Court				$ 64,000.00	
Lighting					
TOTAL				$ 64,000.00	$ 64,000.00
Miscellaneous Site Work					
Stormwater Management				$ 9,000.00	
Utilities				$ 15,000.00	
Retaining Walls				$ 82,000.00	
Pathways				$ 7,500.00	

TOTAL				$ 113,500.00	$ 113,500.00	
Parking Area & Internal Access Drives						
Total Paved Area	78000	sq. ft.	$ 5.00	$ 390,000.00		
TOTAL				$ 390,000.00	$ 390,000.00	
Phase II						
Site Preparation						
Mobilization				$ 10,000.00		
Tree Clearing and Grubbing	8.5	Acres	$ 8,000.00	$ 68,000.00		
Rough Grading	8.5	Acres	$ 7,000.00	$ 59,500.00		
TOTAL				$ 137,500.00	$ 137,500.00	
Junior Soccer Field	200x140					
Soccer Field				$ 100,000.00		
Irrigation				$ 35,000.00		
TOTAL				$ 135,000.00	$ 135,000.00	
Multi-Use Athletic Facility						
Synthetic Turf Field	220x330			$ 620,500.00		
Bleachers	240	Spectators		$ 16,000.00		
lighting				$ 250,000.00		
Track				$ 134,000.00		
Fence				$ 26,000.00		
TOTAL				$ 1,046,500.00	$ 1,046,500.00	
Miscellaneous Site Work						
Stormwater Management				$ 10,000.00		
Utilities				$ 15,000.00		
Retaining Walls				$ 20,000.00		
Pathways				$ 7,500.00		
TOTAL				$ 52,500.00	$ 52,500.00	
Field House/ Concession	34x60					
Building (with Bathrooms and Storage)				$ 125,000.00		
Building Installation Preparation				$ 25,000.00		
Building Installation				$ 50,000.00		
Well				$ 10,000.00		
Septic				$ 30,000.00		

TOTAL					$	240,000.00	$ 240,000.00
Shelter with Concrete Pad							
24'x36' Structure					$	20,000.00	
Building Installation Preparation					$	10,000.00	
Building Installation					$	20,000.00	
TOTAL					$	50,000.00	$ 50,000.00
Parking Area & Internal Access Drives							
Total Paved Area	48500	sq. ft.	$	5.00	$	242,500.00	
TOTAL					$	242,500.00	$ 242,500.00
Project Subtotal							**$ 3,459,500.00**

Table 8: Design Proposal 1 Costs

Phase I			**Design 1**		
Amenities	Dimension		Cost Per Unit	Cost	Subtotal
Site Preparation					
Mobilization				$ 7,000.00	
Tree Clearing and Grubbing	8.5	Acres	$ 8,000.00	$ 68,000.00	
Rough Grading	8.5	Acres	$ 7,000.00	$ 59,500.00	
TOTAL				$ 134,500.00	$ 134,500.00
Little League	200'	Outfield			
Ball field				$ 130,000.00	
Bleachers	84	Spectators		$ 2,500.00	
Irrigation				$ 35,000.00	
TOTAL				$ 167,500.00	$ 167,500.00
Men's Softball					
Ball field					
Bleachers					
Irrigation					
TOTAL					
Senior League Baseball (Multi-Purpose Field in Outfield)	400'	Outfield			
Ball field				$ 200,000.00	
Bleachers	240	Spectators		$ 16,000.00	
Lighting				$ 210,000.00	
Irrigation				$ 35,000.00	
TOTAL				$ 461,000.00	$ 461,000.00
Basketball Court					
Court				$ 64,000.00	
Lighting					
TOTAL				$ 64,000.00	$ 64,000.00
Miscellaneous Site Work					
Stormwater Management				$ 9,000.00	
Utilities				$ 15,000.00	
Pathways				$ 7,500.00	
TOTAL				$ 31,500.00	$ 31,500.00

Parking Area & Internal Access Drives						
Total Paved Area	128,035	sq. ft.	$ 5.00	$ 640,175.00		
TOTAL				$ 640,175.00	$	640,175.00
Phase II						
Site Preparation						
Mobilization				$ 10,000.00		
Tree Clearing and Grubbing	6	Acres	$ 8,000.00	$ 48,000.00		
Rough Grading	6	Acres	$ 7,000.00	$ 42,000.00		
TOTAL				$ 100,000.00	$	100,000.00
Junior Soccer Field	200x140					
Soccer Field				$ 100,000.00		
Irrigation				$ 35,000.00		
TOTAL				$ 135,000.00	$	135,000.00
Multi-Use Athletic Facility						
Synthetic Turf Field	220x330			$ 620,500.00		
Bleachers	240	Spectators		$ 16,000.00		
lighting				$ 250,000.00		
Track				$ 134,000.00		
Fence				$ 26,000.00		
TOTAL				$ 1,046,500.00	$	1,046,500.00
Miscellaneous Site Work						
Stormwater Management				$ 10,000.00		
Utilities				$ 15,000.00		
Retaining Wall				$ 82,000.00		
Pathways				$ 7,500.00		
TOTAL				$ 112,500.00	$	112,500.00
Field House/ Concession	34x60					
Building (with Bathrooms and Storage)				$ 125,000.00		
Building Installation Preparation				$ 25,000.00		
Building Installation				$ 50,000.00		
Well				$ 10,000.00		
Septic				$ 30,000.00		
TOTAL				$ 240,000.00	$	240,000.00

Shelter with Concrete Pad						
24'x36' Structure				$	20,000.00	
Building Installation Preparation				$	10,000.00	
Building Installation				$	20,000.00	
TOTAL				$	50,000.00	$ 50,000.00
Parking Area & Internal Access Drives						
Total Paved Area	17,427	sq. ft.	$ 5.00	$	87,135.00	
TOTAL				$	87,135.00	$ 87,135.00
Project Subtotal						**$ 3,291,810.00**

Table 9: Design Proposal 2 Costs

Phase I			**Design 2**		
Amenities	Dimension		Cost Per Unit	Cost	Subtotal
Site Preparation					
Mobilization				$ 7,000.00	
Tree Clearing and Grubbing	8.5	Acres	$ 8,000.00	$ 68,000.00	
Rough Grading	8.5	Acres	$ 7,000.00	$ 59,500.00	
TOTAL				$ 134,500.00	$ 134,500.00
Little League	200'	Outfield			
Ball field				$ 130,000.00	
Bleachers	84	Spectators		$ 2,500.00	
Irrigation				$ 35,000.00	
TOTAL				$ 167,500.00	$ 167,500.00
Men's Softball	250'	Outfield			
Ball field				$ 150,000.00	
Bleachers	84	Spectators		$ 2,500.00	
Irrigation				$ 35,000.00	
TOTAL				$ 187,500.00	$ 187,500.00
Senior League Baseball (Multi-Purpose Field in Outfield)	400'	Outfield			
Ball field				$ 200,000.00	
Bleachers	240	Spectators		$ 16,000.00	
Lighting				$ 210,000.00	
Irrigation				$ 35,000.00	
TOTAL				$ 461,000.00	$ 461,000.00
Basketball Court					
Court				$ 64,000.00	
Lighting					
TOTAL				$ 64,000.00	$ 64,000.00
Miscellaneous Site Work					
Stormwater Management				$ 9,000.00	
Utilities				$ 15,000.00	
Retaining Wall				$ 82,000.00	

Pathways				$ 7,500.00		
TOTAL				$ 113,500.00	$	113,500.00
Parking Area & Internal Access Drives						
Total Paved Area	99,146	sq. ft.	$ 5.00	$ 495,730.00		
TOTAL				$ 495,730.00	$	495,730.00
Phase II						
Site Preparation						
Mobilization				$ 10,000.00		
Tree Clearing and Grubbing	6	Acres	$ 8,000.00	$ 48,000.00		
Rough Grading	6	Acres	$ 7,000.00	$ 42,000.00		
TOTAL				$ 100,000.00	$	100,000.00
Junior Soccer Field	200x140					
Soccer Field				$ 100,000.00		
Irrigation				$ 35,000.00		
TOTAL				$ 135,000.00	$	135,000.00
Multi-Use Athletic Facility						
Synthetic Turf Field	220x330			$ 620,500.00		
Bleachers	240	Spectators		$ 16,000.00		
lighting				$ 250,000.00		
Track				$ 134,000.00		
Fence				$ 26,000.00		
TOTAL				$ 1,046,500.00	$	1,046,500.00
Miscellaneous Site Work						
Stormwater Management				$ 10,000.00		
Utilities				$ 15,000.00		
Pathways				$ 7,500.00		
TOTAL				$ 32,500.00	$	32,500.00
Field House/ Concession	34x60					
Building (with Bathrooms and Storage)				$ 125,000.00		
Building Installation Preparation				$ 25,000.00		

Building Installation					$	50,000.00	
Well					$	10,000.00	
Septic					$	30,000.00	
TOTAL					$	240,000.00	$ 240,000.00
Shelter with Concrete Pad							
24'x36' Structure					$	20,000.00	
Building Installation Preparation					$	10,000.00	
Building Installation					$	20,000.00	
TOTAL					$	50,000.00	$ 50,000.00
Parking Area & Internal Access Drives							
Total Paved Area	10,800	sq. ft.	$	5.00	$	54,000.00	
TOTAL					$	54,000.00	$ 54,000.00
Project Subtotal							**$ 3,301,730.00**

To better understand the numbers presented the project team has included three pie charts for comparison. Figure 14 is the cost estimation for Charlton created in 2007, Figure 15 is the project team's Design Proposal 1, and Figure 16 is the project team's Design Proposal 2. The three pie charts show similar results but it is important to see clearly how much of the total cost is set by the fields.

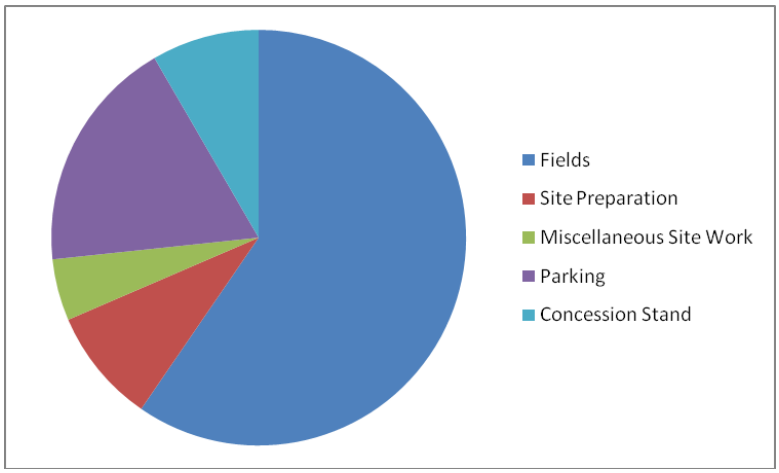


Figure 14: Cost Pie Chart for Charlton's 2007 cost estimation

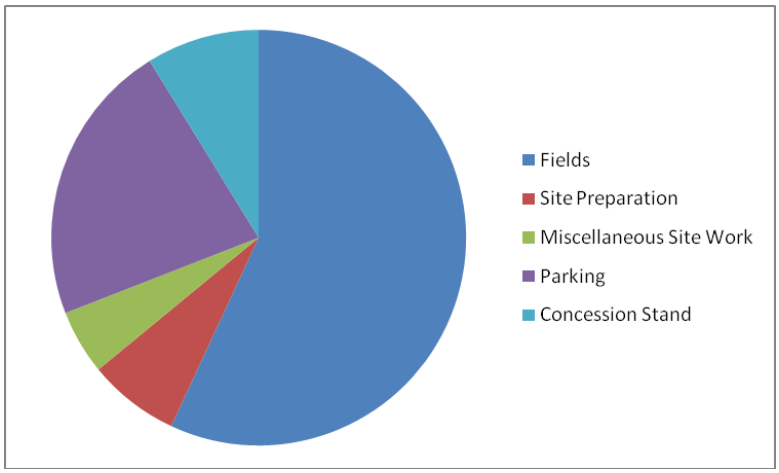


Figure 15: Cost Pie Chart for Design Proposal 1

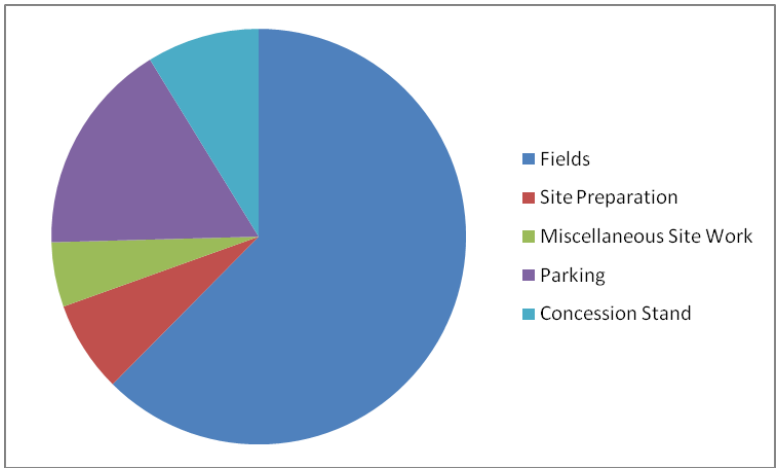


Figure 16: Cost Pie Chart for Design Proposal 2

Evaluation of Options

When evaluating options the outcome usually has great impacts on many stakeholders. To successfully decide on the best option for the Town the project team has created a rubric highlighting features and aspects of each design. The features and aspects were then weighted and each design was given a score. This rubric can be seen in Table 11.

To score each design the project team identified Town priorities and weighted each feature based on the priorities. The highest priority was the ability to accommodate all of the fields. Other features with high priorities include wetland impact, because preserving the environment is very important to the Town of Charlton and the State of Massachusetts. Some areas of lower priority but still factor into the evaluation include the number of parking spaces. The number of parking spaces is of lower priority because in both cases the required amount of parking is met and final count does not make an important difference in which design is better.

Table 10 shows the surface types and percentages of the total area. This chart helps better understand how much of the total area is devoted to which surface type. For instance the project team can identify more stormwater management will be needed for the additional pavement of Design Proposal 1.

Table 10: Surface Types and Percentages

Surface Type Percentage	Design Proposal 1	Design Proposal 2
Turf	72,600 Sq. ft.	72,600 Sq. ft.
Wetland	47% (876,964 Sq. ft.)	47% (876,964 Sq. ft.)
Field Area	11% (201,276 Sq. ft.)	14% (250,785 ft.)
Pavement	8% (145,463 Sq. ft.)	6% (109,946 Sq. ft.)
Free Area	34% (631,103 Sq. ft.)	33% (617,111 Sq. ft.)
Total Area	1,854,807 Sq. ft.	1,854,807 Sq. ft.

Table 11: Evaluation Rubric

	Feature	Points possible	Design Proposal 1	Design Proposal 2	Scores	
					Design 1	Design 2
Fields	400' Senior League Baseball Field	4	Yes	Yes	4	4
	250' Men's Softball Field	4	No	Yes	1	4
	200' Little League Baseball Field	4	Yes	Yes	4	4
	Turf Field	4	Yes	Yes	4	4
	Quarter Mile Track	4	Yes	Yes	4	4
	Basketball Court	4	Yes	Yes	4	4
Environmental Impacts and Status	Stormwater Management	4			3	4
	Wetland Impact	4			2	4
Social Impacts	Functionality	3	For Teens, and Children	For Adults, Teens, and Children	2	3
Flexibility	Expandability	4	Concession stand only	Very little room	3	1
	Constructability in Phases	3	Baseball north of Power Lines	Baseball south of Power Lines	3	2
	Cut-and-fill	3	4 levels	3 levels	3	3
Project Costs	Total Cost	4	3,291,810.00	3,301,730.00	4	4
Design Factors	Road Type	3	Loop	Cul-de-sac	3	2
	Parking Spaces	3	346	264	3	2
	Final Score	55			47	49

The inclusion of the Men's Softball field provides Design Proposal 2 with a higher score than Design Proposal 1. The project team gave a higher score to Design Proposal 2 for wetland impact as well due to the fact that Design Proposal 2 has a cul-de-sac and encroaches on the 20ft no-touch zone less than Design Proposal 1. As for the functionality scoring, Design Proposal 2 received a higher score having more community members targeted with the fields because the little league field suits children of younger ages, the senior league field suits teenagers and young adults, and the softball field suits adults. The expandability scores were much higher for Design Proposal 1 due to the fact that the concession stand has room to add locker rooms and showers while Design Proposal 2 has very little room for expansion of the concession stand. Construction of the complex will be done through phases, which gives Design Proposal 1 a higher score since the baseball fields are more easily accessible compared to the baseball field locations in Design Proposal 2. Design Proposal 2 has the baseball fields on the southern side of the power lines making them harder to get to. As for road type, Design Proposal 1 receives a score of 3 because it is more efficient and creates a smoother flow of traffic while the cul-de-sac is not as smooth and receives a score of 2. Lastly for parking spaces Design Proposal 1 was given the higher score because the amount of parking was substantially larger than Design Proposal 2. The final score line for the two Design proposals shows that Design Proposal 2 received more points than Design Proposal 1.

Recommendations

After identifying elements involved in the process of constructing a sports field complex, the project team would like to recommend to the Town of Charlton to proceed with Design Proposal 2. Design Proposal 2 was given the higher score in the project team's evaluation rubric because of the addition of a softball field and for its wetland impacts. Even though Design Proposal 2 costs slightly more it could potentially bring in more revenue for the town as well, with one extra field to sell advertising space on and bring in more people to buy more products at the concession stand. Both designs fulfill the wants and needs of the Town of Charlton but Design 2 will give the Town more of their wants and needs with the inclusion of the softball field. The project team also recommends that, if the result of the evaluation is deemed too close to make a firm decision, the Town reassess their priorities with the intent of making their decision clearer.

Another suggestion to the Town is for the unoccupied area of the design to remain forested to conserve the environment as much as possible for wildlife and to create a larger buffer for some of the wetlands. An additional suggestion is for the Town of Charlton to perform a traffic study for Flint Road, due to the fact that the increased traffic on an already poor quality road could cause serious problems.

The next step for the Town of Charlton is to create a final design and have it approved by the town before hiring a construction company to begin the construction of the project. The construction company will need to plan, organize, schedule, control, and estimate the final design for construction along with beginning the permitting process. The Town's site plan application requirements would have to be fulfilled as well. According to the Town's website the application process advises "The following information items are required to be prepared by site plan applicants in order to constitute a complete submittal to the Planning Board or Planning Office:

1. Twelve (12) complete copies of the prepared site plan.

2. One cover letter describing the project proposal along with one completed site plan application form (please use attached application form).

3. One complete abutter's list prepared and certified by the Town Assessors Department. The abutter's list must be certified as having been prepared within thirty (30) days prior to the scheduled site plan application submittal.

4. A complete public hearing certified mailing package consisting of the following:

    a. One (1) set of envelopes addressed to abutter's list residents, abutting community Planning Boards, the Mass. DHCD and the Central Mass. Regional Planning Commission (CMRPC). See the attached list for addresses of abutting Planning Boards, DHCD and CMRPC.

    b. One completed USPS certified mailing green card and completed green card receipt for each of the mailing addresses required under 4.a. above. **Note:** Please leave the return address box on the back of the green card blank, the Planning Board Office will complete the return address information on behalf of the Planning Board.

    c. One check or money order to cover the cost of the public hearing certified mailing. Please make the check out to Purchase Power. Calculate the mailing fee amount by multiplying $5.54 times the number of mailings required. Add an additional $20 and round the total upward to the nearest whole dollar (i.e., round $45.37 to $46.00).

5. A site plan application fee of $750.00. Checks or money orders should be made out to the Town of Charlton.

6. Application Submittal Procedure**:** Site Plan submittals are not accepted via either mail or drop-off delivery. All applicants are required to schedule via appointment a pre-application review meeting of the complete application package with Town Planner Alan Gordon. As part of the pre-application meeting, formal submittal of the site plan application to initiate the site plan review under M.G.L. Chapter 40-A and the Charlton Zoning By-Law will be scheduled." (Town of Charlton, 2010)

The Town would then need to identify maintenance and care costs and hire appropriately. After final construction of the site, the Town would then be able to enjoy its new recreational complex.

Conclusion

The goal of this project was to create two new design options for the Flint Road Recreational Complex that accommodated the new Department of Public Works highway facility. Based on the Town of Charlton's requirements for the Complex, the Project Team was able to design two site plans by identifying the constraints of the property, researching the different components of constructing a recreational complex, and utilizing the AutoCAD and ArcGIS programs. The project team was also able to create a list of permits for the Town.

Design Proposal 1 was slightly redesigned from BSC TerraSphere's 2007 site plan. The major changes made to create Design Proposal 1 include the removal of the men's softball field and the relocation of the Senior League Baseball Field. Design Proposal 2 was a complete redesign of BSC TerraSphere's 2007 site plan. The major changes for this Design Proposal was a total revamp of BSC Terrasphere's 2007 site plan with the intention of retaining all of the original site plan's components.

References

Charlton Recreation Commission. (2007). Charlton Community Recreation Complex. Charlton: Charlton Recreation Commission.

Department of Justice (1994). "ADA STANDARDS FOR ACCESSIBLE DESIGN." *U.S. Department of Justice*. N.p., 01 Jul 1994. Retrieved. Aug 19, 2010 from DOJ Web site: http://www.ada.gov/adastd94.pdf.

EPA. (2004). Wetlands Overview. Washington D.C: Office of Water.

EPA. (2009, February 10). National Pollutant Discharge Elimination System (NPDES): Clean Water Act. Retrieved July 15, 2010, from EPA Web site: http://cfpub.epa.gov/npdes/cwa.cfm?program_id=45.

ESRI. "What is GIS?." *GIS software that gives you the geographic advantage*. n.d. Retrieved July 12 2010, from ESRI Web site: http://www.esri.com/what-is-gis/index.html

Executive Office of Energy and Environmental Affairs. (2010). Division of Conservation Services . Retrieved April 21, 2010, from Commonwealth of Massachusetts Web Site: http://www.mass.gov/?pageID=eoeeasubtopic&L=4&L0=Home&L1=Grants+%26+Technical+Assistance&L2=Grant+%26+Loan+Programs&L3=Division+of+Conservation+Services+(DCS)&sid=Eoeea.

Fanger, L. D. (2007). Flint Road Fields. Worcester: BSC Group.

Farrell, Jessica (2010). Interviewed on June 30, 2010 by Quontay Turner. *WPI MQP Question.*

Gauvin, Karen. Interviewed on July 28, 2010 by Nicholas Catano and Quontay Turner. *Meeting with Karen Gauvin.*

MassDEP. (2010). *Drinking water forms*. Retrieved July 26, 2010 from http://www.mass.gov/dep/water/approvals/dwsforms.htm#crosscon.

MassDEP. (2010). *Title 5 septic system forms* . Retrieved July 26, 2010 from http://www.mass.gov/dep/water/approvals/t5forms.htm#construct.

MassDEP (2010). *Wetlands and waterways forms* . Retrieved July 26, 2010 from http://www.mass.gov/dep/water/approvals/wwforms.htm#wetlands.

MassDEP (1997.) *Wetlands Protection Act: Massachusetts General Laws*. Retrieved September 3, 2010 from http://www.mass.gov/dep/water/laws/ch131s40.pdf.

MassDEP (2010). *Wetlands Protection Act: Instructions for eDEP Online Filing*. Retrieved August 18, 2010 from http://www.mass.gov/dep/service/compliance/instru02.htm.

MassDEP (2010). *Wastewater forms.* Retrieved July 26, 2010 from http://www.mass.gov/dep/water/approvals/surffms.htm#npdes2.

MassDEP(2010). *MassDEP's Wetland Information Resource (WIRe).* Retrieved July 26, 2010 from http://www.mass.gov/dep/water/resources/wiremacc.htm

MassDEP and Office of Coastal Zone Management (1997). *Stormwater Management Volume Two: Stormwater Technical Handbook*National Oceanic and Atmospheric Administration.

Mass.Gov (2010) *Bylaw: Parking regulations*. Retrieved from www.mass.gov/Cago/docs/Municipal/sb_parking.rtf.

Metro Council (2008) *Impervious surface reduction: Cul-de-sac Design.* Retrieved from http://www.metrocouncil.org/environment/Water/bmp/CH3_RPPImpCuldeSac.pdf.

MLB.com (2006). "Baseball Field Maintenance." *MLB.com*. Baseball Tomorrow Fund. Retrieved July 15 2010, from Major League Baseball's Web site http://mlb.mlb.com/mlb/downloads/btf_field_maintenance_guide.pdf.

Puhalla, Jim (1999). Sports Fields: A Manual for Design, Construction, and Maintenance. Chelsea, Michigan: Ann Arbor Press. Print.

Town of Charlton. (2008). Charlton Massachusetts 2008: A Business and Community Guide. Charlton: Global Design and Publishing.

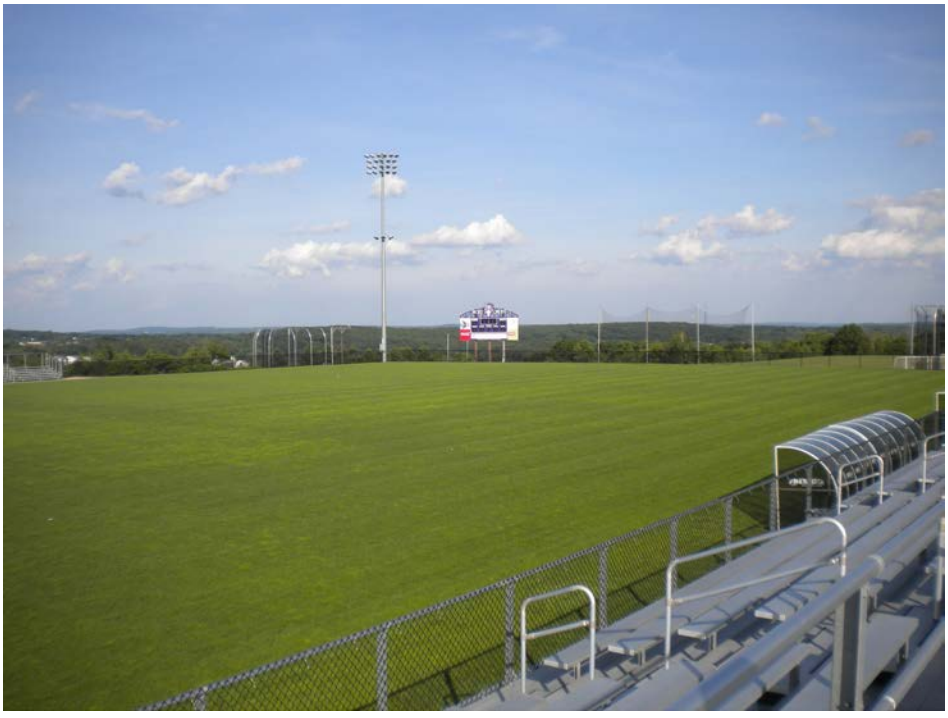
Town of Charlton. (2010). Charlton Municipal Offices. Retrieved April 21, 2010, from Town of Charlton Massachusetts Web Site: http://www.townofcharlton.net/directory.htm.

US Soccer Foundation, (2007). "Lighting Standards of the US Soccer Foundation." US Soccer Foundation. Retrieved July 15 2010, from Major League Soccer's Web site http://www.kintera.org/atf/cf/%7B96EEB400-A57D-4D07-98C9-E16D92B76CE5%7D/LightingStandards.pdf.

Vanasse Hangen Brustlin Inc. (2008). *Town of Charlton 2008 Master Plan.* Watertown: Vanasse Hangen Brustlin Inc.

Appendix A: Field Photos

Multi-use Field 1 at the College of the Holy Cross



Multi-use Field 2 at the College of the Holy Cross

Multi-use Field 3 at the College of the Holy Cross

Astro-turf Lacrosse Field at the College of the Holy Cross

Practice Turf Football Field at the College of the Holy Cross

Multi-use Turf Field at Becker College

Slope and Stormwater Management at Multi-use Field at Becker College

Appendix B: Cut and Fill Calculations

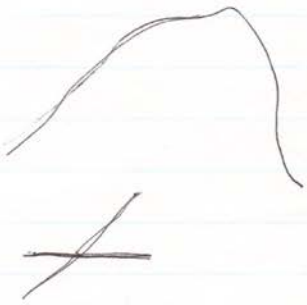
In determining the cut and fill quantities of the Flint Road Site we first determined an elevation for each level of the complex. We then calculated the area of the level that we wanted to grade. After, we divided the area into estimated equal sections and determined the amount of necessary cut or fill to bring it to the desired elevation. For each section of the level we divided, we added the amount of cubic feet needed to bring it to the proper elevation then the resulting cut and fill was totaled and the remainder was our excess cut and fill. We then adjusted the elevation of the levels to reduce the amount of cut and fill left. The final quantities are displayed in Tables 5 and 6. The following images are an example of how the sections were divided and the calculations were determined.

Design 1

Basket ball court → 710 level

little league → 700
Parking level
slow down wet land runoff

Baseball → 680
parking



Athletic field → 655
parking
retaining wall

Design 2

Men's Softball field → 700 level

~~retaining wall around parking lot~~

Parking lot → 710 / 715

10 – 15 ft difference over >15 ft between the 2

Multi Use Athletic field → 685 level

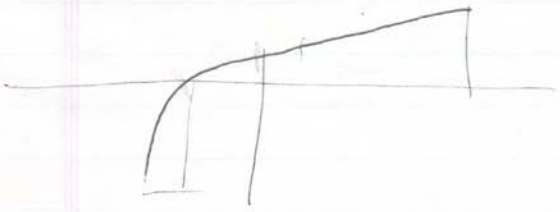
parking lot →
Basketball court
concession stand / picnic area
Parking

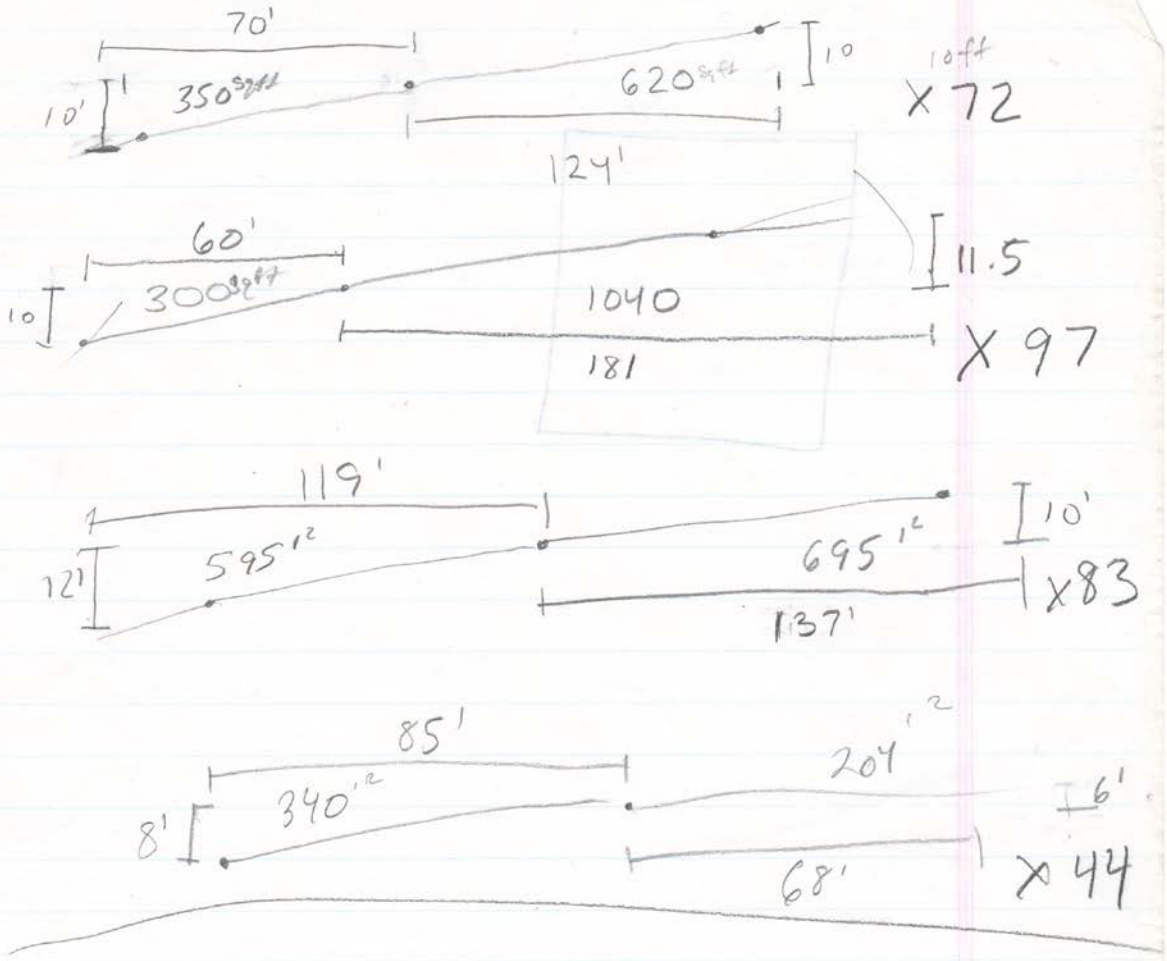
Senior Baseball field → 655 level

retaining wall around south east side

∴ 3 levels for easy AID access

need for slow water runoff into wetland



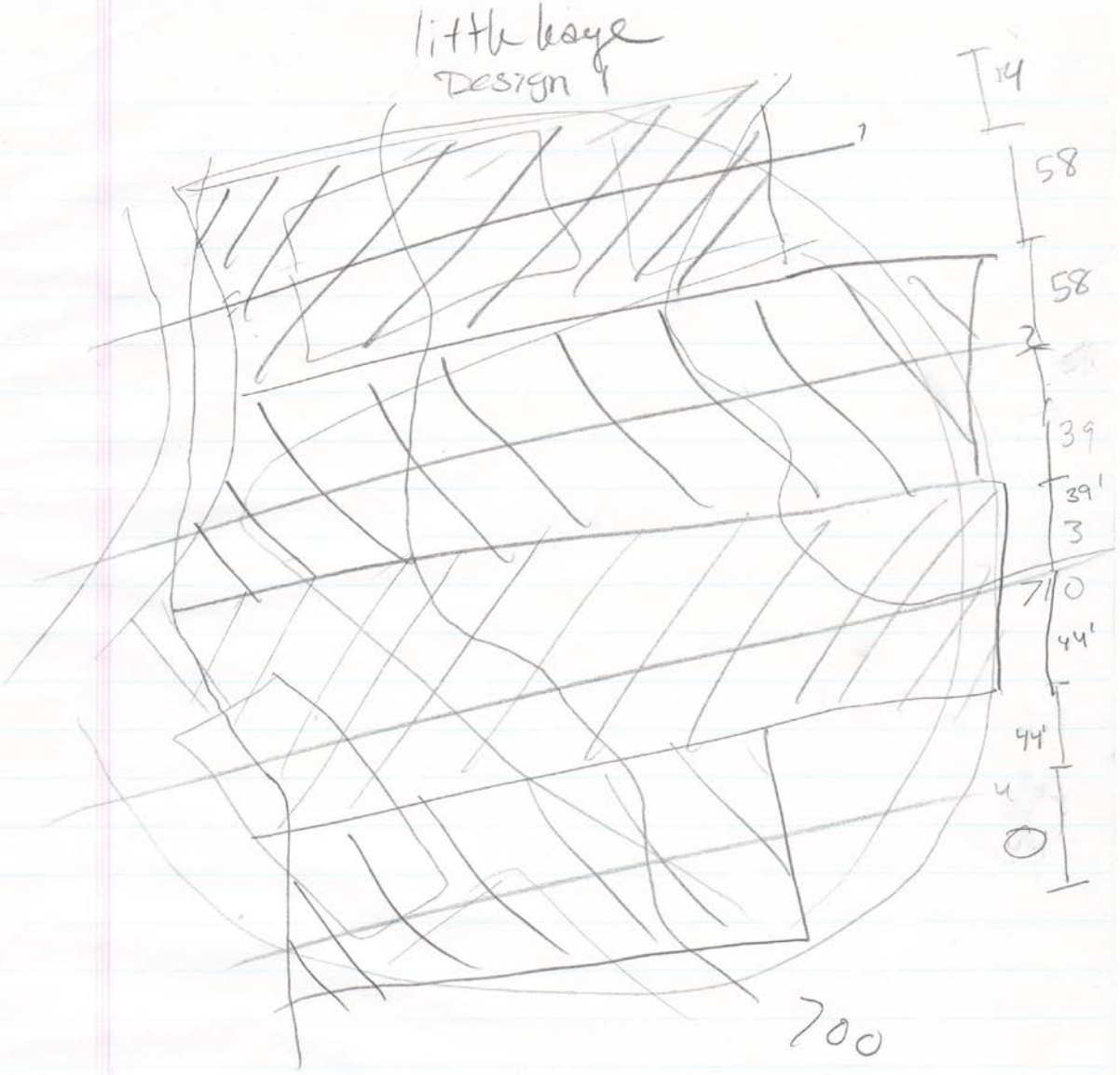


350 × 72 = 25200
300 × 97 = 29100
595 × 83 = 49385
340 × 44 = 14960
118,645

620 × 72 = 44640
1040 × 97 = 100880
695 × 83 = 57685
204 × 44 = 8976
212,181

little league

Design 1



level split into sections

Appendix C: The Stormwater Management Policies for the Flint Road Recreational Complex, Charlton, Massachusetts

Introduction

The Flint Road Site is a hilly forty-five acre plot of land that will soon be Charlton's first lit Recreational Complex. Transforming this heavily wooded site with adjacent wetlands into a recreational complex complete with four flat sports fields will require substantial alteration to the natural layout of the parcel. A successful design must incorporate federal stormwater management regulations to ensure that the site's wetlands will remain ecologically sound and stable.

The purpose of this supplement is to further explore the federal and state stormwater policies and regulations that apply to the Flint Road site to determine what they mean for the development and construction of the site. The goal of this supplement is to take this information and apply it with Best Management Practices (BMPs) to create the best stormwater management plan for the Flint Road Recreational Complex. The layout of this supplement will first cover the history of how the foundation for the current policies came to be. Then the supplement will go into the standards and guidelines that Flint Road will need to abide by, followed by the different permits the site will need for construction. Finally the supplement will address the different BMPs that can be implemented on the Flint Road Project.

Background

Before one can understand the different regulations that the construction and design of Flint Road are subject to, one must first understand how and why those current policies came to be.

The National Pollutant Discharge Elimination System (NPDES)

The Federal Water Pollution Control Amendments of 1972 or more commonly known as the Clean Water Act of 1972 was originally created to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The method in attaining this goal was to regulate pollution from both non-point and point sources (US Senate, 2002). Point sources are defined as sources where pollution is discharging from a certain point, like a pipe emitting

sewage into a lake. Nonpoint sources on the other hand are sources where pollution can be coming indirectly from different locations. An example of this is stormwater runoff into a local pond that may contain fertilizers from a nearby construction site (Environmental Protection Agency, 2010). The Clean Water Act created the National Pollutant Discharge Elimination System (NPDES) in 1972, a permitting program for the sole purpose of "controlling water pollution by regulating point sources that discharge pollutants into waters of the United States" (US Environmental Protection Agency, 2009).

Originally the NPDES was created to regulate point sources of pollution because at that time, people believed that was the main cause of pollution to the Nation's waters. However, after much research, Lawmakers soon came to realize that stormwater runoff was also a large contributor to the problem. In 1987 Congress passed the Water Quality Act which amended the Clean Water Act so that NPDES would also be responsible for stormwater runoff, a nonpoint pollution source (United States Statutes at Large, 1987).

In 1990, the U.S. Environmental Protection Agency developed the regulatory infrastructure for the first Phase of the NPDES Stormwater Permitting Program. Phase II of the program was finalized in 1999 (Florida Department of Environmental Protection, 2010). The NPDES Stormwater Program addresses the problem of pollution from contaminated stormwater runoff, by requiring sites where this may be an issue to have a NPDES Permit in addition to a stormwater management plan or stormwater pollution prevention plan (SWPPP). The sites that are required to have a NPDES stormwater permit are those who meet at least one of the following…

- Operators of Municipal Separate Storm Sewer Systems (MS4s) in urban areas
- Industrial facilities that discharge to MS4s or any body of water,
- Any construction activity (including clearing, grading, excavating, stockpiling, etc.) that disrupts more than an acre of land (Environmental Protection Agency, 2007).

Construction activities in particular have the potential to introduce large quantities of stormwater on site and ruin the local water quality. It is because of this high risk to the local

waters that the NPDES requires sites that include these activities to implement Best Management Practices (BMPs) in their SWPPP to reduce the risk.

The construction of the Flint Road Recreation Complex will include the clearing and grading of roughly twenty two acres that will need to be managed so that runoff during the construction will not severely harm the surrounding wetlands. The site will generate storm water runoff after the construction is finished from its sports fields and parking lots as shown in Figure 13. It is because of this that the site meets the last criterion indicating that it does require a NPDES stormwater permit.

Through the CWA Congress authorizes some states to administer NPDES permits within their boundaries. If a state wishes to administer NPDES permits they must apply to do so through the EPA. The EPA has the power to either approve or deny a state's application. Massachusetts is not authorized to administer NPDES permits. For states that are not authorized to do so, the EPA is the permitting authority. This means that the EPA is in charge of handling and processing all of the required NPDES permits for the state (US Environmental Protection Agency, 2005). The owner or operator of the sites requiring permits can apply for them by contacting their EPA regional representative. For Massachusetts, the EPA Region 1 representative for NPDES storm water permitting is Thelma Murphy (Massachusetts Department of Envionmental Protection, 2010).

The CWA was created to "restore and maintain" our Nation's waters. It is because of this goal that the NPDES under the CWA was put in charge of preventing further pollution by "controlling water pollution" from different sources. The NDPES laid the foundation for future pollution control policies to be set.

Standards and Guidelines for Flint Road

There are many regulations and standards set in place outside of the NPDES to ensure the health and safety of the environment and general public. Depending on the nature of the project and its location, there are certain design standards and guidelines that need to be followed. In particular, when building a Recreational Complex around an area heavily covered in wetlands stormwater guideline and water quality standards must be met.

Massachusetts Stormwater Handbook

The Massachusetts Stormwater Handbook was created in 1996 by the MassDEP and the Massachusetts Office of Coastal Zone Management (MCZM). It was the goal of both these organizations to create "a policy, establishing uniform performance standards and coordinating the requirements of several regulatory programs" (Stormwater Management: Volume One Stormwater Policy Handbook, 1997). This Handbook offers a variety of approaches to managing stormwater runoff and different aspects of the management plan to be cognizant of for the Flint Road site.

One of the sections in the Handbook is the *Stormwater Policy Handbook,* which promotes consistent implementation of the policy and performance standards. There are nine performance standards. The following seven are applicable to the Flint Road development.

- Standard 1: No new stormwater conveyances may discharge untreated stormwater directly to or cause erosion in Massachusetts' waters
- Standard 2: Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.
- Standard 3: Loss of annual recharge to groundwater should be minimized and the annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site conditions, based on soil types.6
- Standard 4: For new development like the Flint Road Project, stormwater management systems must be designed to remove 80% of the average annual load based on post-development conditions of Total Suspended Solids (TSS).
- Standard 5: Stormwater discharges from areas with higher potential pollutant loads must use specific stormwater management BMPs, however the use of infiltration practices without pretreatment is prohibited.
- Standard 8: Erosion and sediment controls must be implemented to prevent impacts during construction activities.
- Standard 9: All stormwater management systems must have an operation and maintenance plan to ensure that the system functions as designed (Massachusettes

Department of Environmental Protection & Massachusetts Office of Coastal Zone Managment, 1997)

Another section in the Handbook is the *Stormwater Technical Handbook* that consists of technical information about site planning and stormwater management techniques. Within this section there is language that specifically addresses Turf management which is a main component for Flint Road and key contributor to the stormwater runoff of the site. Some of the areas addressed under Turf management section include proper pesticide use and application, composting to address solid waste, and climate and resource conscious landscaping (Stormwater Management Volume Two: Stormwater Technical, 1997).

These standards and practices will need to be followed when constructing the Flint Road recreational complex to prevent stormwater runoff and its pollutants from negatively impacting the wetlands on site.

Surface Water Quality Standards

The Massachusetts Surface Water Quality Standards (314 CMR 4.00) are in place "to protect the public health and enhance the quality and value of the water resources of the Commonwealth." This document has different water quality standards for each class of surface water throughout the state of Massachusetts. The wetlands on the Flint Road site are designated as Class B.

According to the Standards, the Flint Road wetlands must meet the following standards in the given categories…

- Dissolved Oxygen: shall not be less than natural background conditions. Natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- Temperature: natural seasonal and daily variations that are necessary to protect existing and designated uses shall be maintained.
- pH: shall be in the range of 6.5 through 8.3 standard units and not more than 0.5 units outside of the natural background range.

- Bacteria: the geometric mean of all E. coli samples taken within the most recent six months shall not exceed 126 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 235 colonies per 100 ml; alternatively, the geometric mean of all enterococci samples taken within the most recent six months shall not exceed 33 colonies per 100 ml typically based on a minimum of five samples and no single sample shall exceed 61 colonies per 100 ml. These criteria may be applied on a seasonal basis at the discretion of the Massachusetts Department of Public Health.
- Solids: These waters shall be free from floating, suspended and settable solids in concentrations and combinations that would degrade the natural quality of the water or impair the benthic biota or degrade the chemical composition of the bottom.
- Color and Turbidity: These waters shall be free from color and turbidity in concentrations or combinations that that would degrade the natural quality of the water.
- Oil and Grease: These waters shall be free from oil, grease and petrochemicals that produce a visible film on the surface of the water (Massachusetts Surface Water Quality Standards (314 CMR 4.00), 2007).

Since the Flint Road wetlands are for the most part seasonal, testing for these categories is based on the wetland's seasonal presence on site. It is important that Flint road follow these standards because the Surface Water Quality Standards are meant to improve existing surface waters as well as help to prevent water pollution.

The Standards specifically target restrictions from point source pollution but also lends itself to nonpoint sources as well. Since Flint Road is dealing with nonpoint sources, it is important that the operator of the site provide the MassDEP with BMPs that will be used to help manage the runoff. This is necessary because the Standards state that the discharge of pollutants from those sources to any surface water may be required to provide the MassDEP with BMPs that

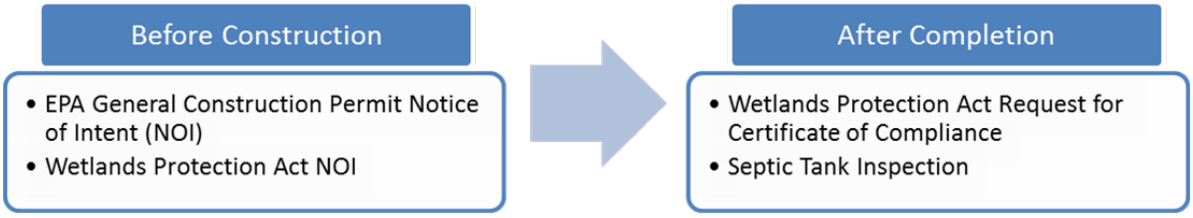
would help mitigate the discharge (Massachusetts Surface Water Quality Standards (314 CMR 4.00), 2007).

The Surface Water Quality Standards are important to follow for the Flint Road site because of wetlands on site. These wetlands are a gateway to the ground water supply and in turn the public's health. It is imperative to keep these wetlands up to these standards so that the ground water will be safe for nearby residents with wells. The Surface Water Quality Standards work in conjunction with the Stormwater Management Handbook to prevent future pollution from contaminating the site as well as improving the existing conditions of the wetlands to ensure public health.

Permits Required for Flint Road

The Town of Charlton will need to secure three permits from different entities in order to design and construct the Flint Road recreational complex to all federal and state regulations. These permits are set in place to help mitigate the impact on the environment.

Figure 17: Timing for the Acquisition of Permits



EPA General Construction Permit

One of the main permits that Flint Road will require is a General Construction Permit (GCP) from the EPA. This permit is the same as a NPDES general stormwater permit. Since the EPA is the permitting authority in Massachusetts the contractor for the Flint Road project will need to go through the EPA to obtain this permit.

The first step in applying for the GCP is making sure the site is eligible for coverage under the 2008 GCP. Since Massachusetts is covered by the EPA, Flint Road is covered under GCP. Next, the contractor will need to submit a Stormwater Pollution Prevention Plan (SWPPP) outlining what best management practices will be used to control stormwater runoff on the

construction site. After this is complete, they will need to submit a Notice of Intent (NOI) for Stormwater Discharges Associated with Construction Activity under the NPDES General Permit. By completing and submitting the NOI, the contractor is agreeing to comply with terms in the GCP (Environmental Protection Agency, 2009).

Coverage under the GCP begins once the NOI has been submitted or when it is designated in the permit once it is received. It is after the NOI has been submitted that the contractor will need to begin implementing the SWPPP and periodically assess its performance and reporting it as described in the permit. Any changes to the plan will need to be documented (Massachusetts Department of Envionmental Protection, 2010)

The contractor must follow all terms stated in the permit until it is expired or a Notice of Termination is filed with the EPA. The General Construction Permit typically is valid for 5 years unless specified in the document (Massachusetts Department of Envionmental Protection, 2010).

Construction & Development Effluent Limitations Guideline

The requirements for obtaining a General Construction Permit are described in the Construction and Development Effluent Limitations Guideline, which was created by the EPA. The purpose of this was to further attempt to prevent stormwater runoff during site construction. The guideline was made final on December 1, 2009.

The final rule requires that "construction site owners and operators implement a range of erosion and sediment control measures and pollution prevention practices to control pollutants in discharges from construction sites." In addition to this, Construction sites that disturb more than 10 acres at a time are required to do periodical testing of stormwater discharge to ensure that the effluent is not above the numeric standards set in the guidelines (EPA Fact Sheet Final Rule: Effluent Guidelines for Discharges from the Construction and Development Industry, 2009). Because Flint Road will disturb more than 10 acres at a time, testing of the stormwater runoff will need to be completed.

Wetlands Protection Act Massachusetts

The Wetlands Protection Act (WPA) is enforced by the Commissioner of the Massachusetts Department of Environmental Protection (MassDEP). The purpose of this Act is to preserve Massachusetts' wetlands by protecting public, private and ground water supply, fisheries and wildlife habitats, along with mitigating storm damage and pollution (Wetlands Protection Act (M.G.L. c. 131, § 40.), 2009). In order to fulfill this purpose, the Act "prohibits the removal, dredging, filling, or altering of wetlands without a permit" (Massachusetts Department of Environmental Protection, 2008). The following areas are covered on the WPA…

- Any bank, the ocean; any freshwater wetland; any estuary; any coastal wetland; any creek; any beach bordering any river; any dune on any stream; any flat, pond, marsh, pond, or swamp
- Land under any of the water bodies listed above
- Land subject to tidal action
- Land subject to coastal storm flowage
- Land subject to flooding
- Riverfront area (Wetlands Protection Act (M.G.L. c. 131, § 40.), 2009)

On the Flint Road site, roughly forty seven percent of the land is wetlands. It is the goal of the Town of Charlton and their Conservation Commission to avoid altering or disturbing the wetlands on site. To help attain this goal, a twenty-foot buffer zone surrounding all wetlands was included in the design of the complex. The size of the buffer zone was determined by how much space was available on site to incorporate all the necessary components including the buffer zone itself. While Massachusetts state laws encourage a buffer zone of at least one hundred feet, in the case of Flint Road, anything larger than twenty feet would have restricted the space for the complex. It is stated in the WPA that any activity other than minor activities within 100 feet of the areas protected under the Act is subject to regulation and requires the filing of a WPA NOI (Wetlands Protection Act (M.G.L. c. 131, § 40.), 2009). Since the buffer zone for the Flint Road project is only twenty feet, it will require the contractor to complete a the NOI in order to receive a WPA permit called an Order of Conditions (Bureau of Resource Protection WPA Form 3-Notice of Intent, 2008). Once construction for the project is complete,

the property owner will need to complete a WPA Request for Certificate of Compliance. All of the WPA forms will need to be submitted to the Charlton Conservation Commisson in addition to the MassDEP. Since Charlton's Conservation Commision is heavily involved in this construction and design of this project, it will be designed to the standards of the Wetlands Protection Act.

WPA NOI

WPA form 3 is the Notice of Intent. It provides the MassDEP with a detailed description of the site and all the resources covered under the Act along with the proposed work to be completed including the design specifications that will need to meet the Acts standards (Bureau of Resource Protection WPA Form 3-Notice of Intent, 2008). In addition to information about the site, its construction activities and the resources it impacts, this form requires a wetland assessment fee to be calculated and paid for by the Town of Charlton.

The wetland assessment fee will be based on the category of the proposed activity and the resource area that it will affect. In order to calculate the fee, the Town will first need to review the construction plans and identify each activity and its quantity that falls in the jurisdiction of the WPA, in the case of Flint Road it would include any activity within the 100 foot buffer zone. After this is determined, each activity has an assigned fee based on Table 1 and the total of all activities and their respective fees will be the subtotal fee for the NOI. In additional to this subtotal, there is a clause in the form that states, "If the activity is within the Riverfront Area as well as another resource area or its Buffer Zone, add 50% to total fee" (Bureau of Resource Protection WPA Form 3-Notice of Intent, 2008). Since Flint Road is not located on a Riverfront Area, the Town will not need to add 50%.

Table 12: Category Activities and Fees (Bureau of Resource Protection WPA Form 3 - Notice of Intent, 2008)

Cost	Description of Activity
Category 1 ($110 per Activity)	Work on single family lot; addition, pool, etc.
	Site work without a house
	Control vegetation

	Resource improvement
	Work on septic system separate from house
	Monitoring well activities minus roadway
	New agricultural or aquaculture projects
Category 2 ($500 per Activity)	Construction of single family house
	Parking lot
	Beach nourishment
	Electric generating facility activities
	Inland limited projects minus road crossings and agriculture
	Each crossing for driveway to single family house
	Each project source (storm drain) discharge
	Control vegetation in development
	Water level variations
	Any other activity not in Category 1, 3, 4, 5 or 6
	Water supply exploration
Category 3 ($1,050 per Activity)	Site preparation (for development) beyond Notice of Intent scope
	Each building (for development) including site
	Road construction not crossing or driveway
	Hazardous cleanup
	Water supply development
Category 4 ($1,450 per Activity)	Each crossing for development or commercial road
	Dam, sluiceway, tide gate (safety) work
	Landfills operation/closures
	Sand and gravel operations
	Railroad line construction
	Bridge
	Hazardous waste alterations to resource areas
	Dredging
	Package treatment plant and discharge
	Airport tree clearing
	Oil and/or hazardous material release response actions
Category 5 ($4 per linear foot; total fee not less than $100 or more than $2,000)	Work on docks, piers, revetments, dikes, etc. (coastal or inland)

Category 6 ($2 per linear foot for each resource area): For each resource area delineation, the fee shall not exceed $200 for activities associated with a single family house or $2,000 for all other activities).	Bordering vegetated wetland, riverfront area, bordering land subject to flooding, etc.

For large projects like the Flint Road Recreational Complex this wetland fee can be expensive; however for all filing fees for this form the state pays 50% plus half of the $25 application fee of any total exceeding $25 (Bureau of Resource Protection WPA Form 3-Notice of Intent, 2008).

Depending on the nature of the site additional information or forms may be needed. Item 1 under the WPA NOI form requires applicants to make sure their site is not located on a Rare Wetland Wildlife Habitat. Any and all work is strictly prohibited in these areas, except for Designated Port Areas, to ensure the preservation of the ”rare, ‘state-listed’ vertebrate or invertebrate animal species’ [habitats]” (Bureau of Resource Protection WPA Form 3-Notice of Intent, 2008). Even though there are Rare Wetland Wildlife Habitats in the Town of Charlton, none reside on the Flint Road site so construction is permitted (National Heritage & Endangered Species Program, 2008). In addition to determining if the site is in a Rare Wetland Wildlife Habitat, the applicants must also determine if any part of the site is subjected to a Wetlands Restriction Order under the Inland Wetlands Restriction Act Section 40A (Bureau of Resource Protection WPA Form 3-Notice of Intent, 2008). There are over 50 communities in Massachusetts that are subjected to a Wetlands Restriction Order. This order is in place to provided added protection to vital wetlands such as Buzzard’s Bay which is protected under the order (Massachusetts Department of Environmental Protection, 2010). If located in an area subjected to the restriction, a copy of the order will need to be attached to the NOI (Bureau of Resource Protection WPA Form 3-Notice of Intent, 2008).

For the Flint Road site, stormwater management is needed and the WPA NOI states that any site in which this is necessary, applicants must submit a Stormwater Report with their NOI

to provide stormwater management information that complies with the WPA for the local Conservation Commission (Bureau of Resource Protection WPA Form 3-Notice of Intent, 2008). Within the report must be the following…

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer that certifies that the Stormwater Report contains all required submittals.
- Name of Firm and Registered Professional Engineer that prepared the Report along with the Project/Owner information
- Compliance with the standards set forth in the Massachusetts Stormwater Handbook for the Long-Term Pollution Prevention Plan: Standards 4-6; the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan: Standard 82; and the Operation and Maintenance Plan: Standard 9
- A brief description of the stormwater management practices, including environmentally sensitive site design and Low Impact Development (LID) techniques, along with a diagram depicting runoff through the proposed BMP treatment train
- All plans included in the report must show existing and proposed conditions; identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), any areas on the site where infiltration rate is greater than 2.4 inches per hour, and the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations (Bureau of Resource Protection Wetlands Program-Checklist for Stormwater Report, 2008)

Once the WPA NOI is complete the Town will need to submit it to their MassDEP regional office to receive their Order of Conditions permit. The Town of Charlton will need to send their paperwork to the MassDEP Central Regional Office (Massachusetts Department of Environmental Protection, 2010).

WPA Request for Certificate of Compliance

WPA form 8A is the Request for Certificate of Compliance, the last form needed to be filled out by owner of the property which would be the Town of Charlton in the case of the Flint Road site. Upon the completion of the construction activities approved by the Order of

Conditions, the Town must file a the Request for Certificate of Compliance from the MassDEP stating that the work has been completed to satisfy the WPA standards (Massachusetts Department of Environmental Protection, 2004)

Disposal System Construction Permit

The site for the Flint Road Recreational Complex is currently undeveloped. There is no previous infrastructure to build upon. One of the important components needed for the site is a septic system to address waste management on site. The application for Disposal System Construction Permit is required for the construction of a new septic system or repairs to an existing one. This permit is in accordance with Title 5 of the Environmental Code of Massachusetts (310 CMR 15.000) whose purpose is to "protect public health and environmental resources by regulating the discharge of sewage." Under this code any septic systems generating less than 10,000 gallons per day are regulated by local Boards of Health, while any system generating more than 10,000 gallons will need to be reviewed and approved by the MassDEP (20. State Environmental Code (Title 5), 2003).

Based on an estimated maximum service to 648 spectators, the Complex will require a septic system that will support 8,035 gallons per day (City of Tampa Florida, 2010). Since this will not exceed 10,000 gallons per day therefore the Town will not need to fill out an application for Disposal System Construction Permit. Instead, the Town will simply need to have the septic system they chose to install inspected by James F. Malley Jr. P.E., the Board of Health Agent in charge of septic systems (Town of Charlton, 2010)

Best Management Practices for Flint Road

Best Management Practices (BMPs) are strategies that are used to mitigate negative human impact on the environment. These strategies are created and tested scientifically by different organizations, which are then endorsed and promoted for use by federal departments. For stormwater management the EPA works with the American Society of Civil Engineers (ASCE), Water Environment Research Foundation (WERF), and other organizations to create the BMP database comprised of over 400 BMP studies (Clary, 2010).

For Flint Road, the key to creating a Recreational Complex that will have minimal impact on the integrity of the wetlands on site is to be strategic with the construction of a good stormwater management plan. There are BMPs that can be applied during the construction of the project as well as throughout the entire life of the site far past its completion.

Site Design

While BMPs during the construction of a site are important, the BMPs implemented in the site design are even more vital. BMPs for the site design impact the environment not for just a short period of time like those used during construction, but for the entire life of the site. It is because of this that so much of the focus in the stormwater management is focused on the final site design.

One of the main BMPs that the Flint Road site can utilize for their stormwater pollution prevention plan is using well graded slopes to guide the runoff into wetland buffers. This works well for Flint Road because the site naturally slopes down to the wetlands, where the vegetated twenty-foot buffer zone can filter out pollutants and allow the water to filter back into the ground (Stormwater Management Volume Two: Stormwater Technical, 1997).

Another common BMP is to reduce the amount of imperious surfaces on site. While this may be difficult for a site mainly composed of sports fields and parking lots, it is not unachievable. Even though one cannot change the components of the complex, the materials used for them can be altered. By using asphalt with a high porosity or even gravel for the roads and parking lots, the amount of runoff can be greatly reduce as compare to a regular asphalt or concrete (Stormwater Management Volume Two: Stormwater Technical, 1997).

While using the highest quality of materials in the BMPs is the best way to maximize the project's life and assist in minimizing the amount of stormwater runoff, it often comes at a price. Since the Recreational Complex is being built by the Town, the money to fund the project is coming mainly through fundraisers. Based on how much the Town is able to collect will determine the quality of materials they will be able to secure for the project. Because that amount has yet to be determined, the best way to minimize the stormwater runoff on site is to focus on the BMPs themselves and not the materials used for them.

During Construction

During the construction of a project it is important to implement a variety of BMPs so that stormwater runoff does not jeopardize the integrity of the surrounding wetlands and environment during construction. This is especially important when the construction activities include grading and clearing.

Construction Sequencing

Construction sequencing can help to reduce the impact on the site by completing the project in strategic increments. By implementing erosion and sediment control methods at each stage of the project, it makes managing stormwater runoff easier because the quantity is smaller. Construction sequencing also helps to reduce the initial shock the activity has on the environment (Environmental Protection Agency, 2006).

While the goal of construction sequencing is to reduce on-site erosion and off-site sedimentation, it also aids in making the scope of the project much easier to handle (Environmental Protection Agency, 2006). Flint Road will need to be completed in phases to help make the construction of the complex easier. By completing certain areas of the project first, they then can use cut that came from one part of the site to fill in others. This eliminates the need to import fill material.

BMP Inspections

Consistently checking on the site's BMPs can be a BMP in itself. By performing routine inspections of the site's BMP, the operator can ensure that their methods are working, and if not address them accordingly. Take for example the method of using barriers such as sandbags to manage erosion. By inspecting the placement of the bags routinely as well as before and after a storm the operator will be able to manipulate them so that they will be the most effective. This method can be used for the Flint Road site in particular because grading will be a major factor in the construction and barriers are a good way to reduce the erosion of the land

Preserving Natural Vegetation

Preserving as much natural vegetation as possible on a construction site is an effortless BMP for stormwater runoff and erosion control. By doing this the vegetation is holding the soil together, making it harder for it to erode. In addition to keeping the soil together, the

vegetation also absorbs stormwater that would otherwise end up in other areas of the construction site or become runoff to the surrounding environment. By far this is one of the cheapest and easiest BMPs to implement because besides providing fencing for protection, the vegetation is free, already installed and requires little maintenance (Environmental Protection Agency, 2006).

For the Flint Road Recreational Complex this method can be used in conjunction with construction sequencing. Since the nature of the project is flat recreational sports fields and parking lots, not much vegetation will be able to remain. However, when completing the project in phases, the areas that are not being worked on can remained vegetated to help manage the runoff from the areas where construction is taking place.

Conclusion

Before designing and constructing any development it is important to know how its location will affect if and how you go about completing your project. Each state has its own standards, regulations, laws and permits required for any new construction. Knowing this information before breaking ground will save money and delays in construction.

For the Flint Road Site, wetlands were the main concern behind all of the laws and permits needed for construction. It is important to know the local, state, and federal regulations of your project before beginning work. It was these laws and guidelines of the Town of Charlton, the Commonwealth of Massachusetts and the Unites States that ultimately shaped the design of the complex and determined how it would be built.

References

United States Statutes at Large. (1987, April 2). *Water Quality Act of 1987 (101 Stat. 7-90)*. Retrieved January 5, 2011, from Global Legal Information Netwok: http://www.glin.gov/view.action?glinID=71638

City of Tampa Florida. (2010, August 9). *Water Use Calculator*. Retrieved January 15, 2011, from TampaGov: http://www.tampagov.net/dept_water/information_resources/saving_water/Water_use_calculator.asp

Clary, J. (2010). *International Stormwater Best Management Practices* . Retrieved January 15, 2011, from BMP Database: http://www.bmpdatabase.org/index.htm

Environmental Protection Agency. (2006, May 24). *Construction Sequencing*. Retrieved January 7, 2011, from EPA-NPDES: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=51&minmeasure=4

Environmental Protection Agency. (2006, May 24). *Preserving Natural Vegetation*. Retrieved January 7, 2011, from EPA-NPDES: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=34&minmeasure=4

Environmental Protection Agency. (2007, February 1). *Stormwater Frequently Asked Questions*. Retrieved January 4, 2011, from EPA-NPDES: http://cfpub.epa.gov/npdes/faqs.cfm?program_id=6#1

Environmental Protection Agency. (2009, January 4). *Applying for Coverage under the Construction General Permit (CGP)* . Retrieved January 13, 2011, from EPA-NPDES: http://cfpub.epa.gov/npdes/stormwater/application_coverage.cfm#mail

Environmental Protection Agency. (2009, December 1). *Construction and Development Final Rule.* Retrieved January 4, 2011, from EPA-Water: http://edocket.access.gpo.gov/2009/E9-28446.htm

Environmental Protection Agency. (2009, November). *EPA Fact Sheet Final Rule: Effluent Guidelines for Discharges from the Construction and Development Industry.* Retrieved January 4, 2011, from EPA- Water:

http://water.epa.gov/scitech/wastetech/guide/construction/upload/2009_11_23_guide_construction_files_c_and_d_final_rule_factsheet.pdf

Environmental Protection Agency. (2010, April 15). *What is Nonpoint Source Pollution?* Retrieved January 12, 2011, from EPA: http://water.epa.gov/polwaste/nps/whatis.cfm

Florida Department of Environmental Protection. (2010, November 17). *National Pollutant Discharge Elimination System*. Retrieved January 5, 2011, from Florida DEP: http://www.dep.state.fl.us/water/stormwater/npdes/

Massachusettes Department of Environmental Protection & Massachusetts Office of Coastal Zone Managment. (1997). *Stormwater Management Volume Two: Stormwater Technical.* Boston: National Oceanic and Atmospheric Administration.

Massachusettes Department of Environmental Protection & Massachusetts Office of Coastal Zone Managment. (1997). *Stormwater Management: Volume One Stormwater Policy Handbook.* Boston: National Oceanic and Atmospheric Administration.

Massachusetts Department of Envionmental Protection. (2010). *How an NPDES Stormwater General Permit Works*. Retrieved January 5, 2011, from MassDEP-Water, Wastewater, and Wetlands: http://www.mass.gov/dep/water/approvals/howperm.htm

Massachusetts Department of Environmental Protection. (2003). *20. State Environmental Code (Title 5)*. Retrieved January 7, 2011, from Massachusetts Office of Coastal Zone Management: http://www.mass.gov/czm/permitguide/regs/title5.htm

Massachusetts Department of Environmental Protection. (2004, July). *Wetlands Protection Act Permits*. Retrieved January 7, 2011, from MassDEP-Wetlands and Waterways Forms: http://www.mass.gov/dep/water/approvals/wwforms.htm#noi

Massachusetts Department of Environmental Protection. (2007, January). *Massachusetts Surface Water Quality Standards (314 CMR 4.00).* Retrieved January 7, 2011, from MAssDEP-Regulations & Standards: http://www.mass.gov/dep/service/regulations/314cmr04.pdf

Massachusetts Department of Environmental Protection. (2008, April 1). *Bureau of Resource Protection Wetlands Program-Checklist for Stormwater Report*. Retrieved January 7, 2011, from MassDEP-Wetlands and Waterways Forms: http://www.mass.gov/dep/water/laws/swcheck.pdf

Massachusetts Department of Environmental Protection. (2008, February 21). *Bureau of Resource Protection WPA Form 3-Notice of Intent.* Retrieved January 6, 2011, from

MassDEP-Wetlands and Waterways Forms: http://www.mass.gov/dep/water/approvals/wpaform3.pdf

Massachusetts Department of Environmental Protection. (2009, June). *Wetlands Protection Act (M.G.L. c. 131, § 40.)*. Retrieved January 5, 2011, from MassDEP-Regulations & Standards : http://www.mass.gov/dep/service/regulations/310cmr10a.pdf

Massachusetts Department of Environmental Protection. (2010). *Find the MassDEP Regional Office for Your City or Town* . Retrieved January 7, 2011, from MassDEP: http://www.mass.gov/dep/about/region/findyour.htm

Massachusetts Department of Environmental Protection. (2010). *Protecting Wetlands in Massachusetts* . Retrieved January 14, 2011, from MassDEP-Water, Wasterwater, and Wetlands: http://www.mass.gov/dep/water/resources/protwet.htm

National Heritage & Endangered Species Program. (2008). *2008 Priority Habitat & Estimated Habitat*. Retrieved January 7, 2011, from MassGIS: http://maps.massgis.state.ma.us/PRI_EST_HAB_TEST/viewer.htm

Town of Charlton. (2010). *Board of Health*. Retrieved January 15, 2011, from Town of Charlton Massachusetts: http://www.townofcharlton.net/boardofhealth.htm

US Environmental Protection Agency. (2005, January 7). *State and Tribal Program Authorization Status* . Retrieved January 5, 2011, from EPA-NPDES: http://cfpub.epa.gov/npdes/statestribes/astatus.cfm

US Environmental Protection Agency. (2009, March 12). *National Pollutant Discharge Elimination System (NPDES)*. Retrieved Dec 15, 2010, from epa.gov: http://cfpub.epa.gov/npdes/index.cfm

US Senate. (2002, November 27). *FEDERAL WATER POLLUTION CONTROL ACT (33 U.S.C. 1251 et seq.).* Retrieved December 13, 2010, from EPA-Laws & Regulations: http://epw.senate.gov/water.pdf